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Engineering and Contracting

Devoted to the Economics of Civil Engineering Design and to Methods and Costs of Construction

190100
27.6.24

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Vol. LX, July-December, 1923

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Roads and Streets

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.

221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*

LEWIS S. LOUER, *Vice-President and General Manager*

New York Office: 904 Longacre Bldg., 42d St. and Broadway

RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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Vol. LX. CHICAGO, ILL., JULY 4, 1923 No. 1

Sophistical Arguments Against Long Time Highway Bond Issues

Illinois newspapers have recently published many editorials against the proposed 30-year hundred million highway bond issue. Editorials may not express public opinion, but they tend to form public opinion and are therefore not to be ignored when they teach false economics. From the Rock Island Argus we quote part of an editorial that summarizes Senator Kissinger's argument against the bond issue:

"The $100,000,000 bond issue will cost $90,000,000 in interest.

"I oppose this bond issue because:

"First, we owe enough already.

"Second, it is wasteful to spend $90,000,000 for interest which can be spent on roads.

"Third, if the license fees come in we don't need the bonds.

"Fourth, if the fees don't come in we can't pay the bonds.

"Fifth, the danger of a direct tax.

"Sixth, we will have the bonds to pay long after the roads have been destroyed by the conditions of climate and traffic.

"Seventh, the Republican party in Illinois cannot afford to foist on the taxpayers a bond issue so economically unsound and so politically unwise as the proposed issue."

The argument that interest paid on road bonds is "wasteful," applies equally to interest paid on any form of loan. It would be just as sound to contend that a man should not borrow money from a building and loan association in order to finance the erection of a home. All arguments of this sort are sophistical, for they consider only one side of the ledger. If a home owner pays interest on a mortgage, he is justified by the sav-

ing he affects in rent. Similarly if taxpayers pay interest on road bonds, they find justification in the saving affected in the cost of highway transportation.

The argument that motor car license fees would pay for the roads needed is sophistical, because license fees would barely pay bond interest charges and would not begin to suffice to cover the full first cost of necessary road improvement. License fees and gasoline taxes should be regarded as income paid by motor car operators for the use of the roads, being essentially the same as the freight and passenger income of railways. Freight and passenger income are not expected to pay more than operating expenses and a fair return on the capital invested in railways. Why, then, should license fees and gasoline taxes be expected to do more than is expected of freight and passenger income?

The argument that bonds will have to be paid off long after the highway has been destroyed is fallacious for several reasons. First, an improved road is even more permanent than a railway. Road surfaces, it is true, wear out, but ties and rails rot and wear out even faster. As renewals of ties and rails are not paid for by new bond issues, so renewals of road surfaces should not be paid for by new bonds. The useful life of the structure or plant taken as a whole should of course exceed the life of the bonds, but the opponents of long time road bonds befuddle this economic principle when they try to make it appear that the life of the road surface is synonymous with the life of the road as a whole.

There has been not a little error on the part of daily paper editors as to the average life of road surfaces. Several Illinois editors have said that during a bond term of 30 years "the roads will have been worn out and replaced several times." Of course, practically none of the roads will have been replaced as a whole at the end of thirty years, and the editors obviously have in mind only the road surface. But we should like to know their authority for asserting that even the surface of the average improved road will be renewed several times in 30 years. It is our opinion that the surface of the average improved road will show a life exceeding 20 years. There will, of course, be exceptions, but we are speaking of averages.

Where a pavement is made thick enough to provide for the heaviest probable wheel loads, it should have a life of fully 30 years on the average highway.

The Durability of Copper-Bearing Steel

In our issue of June 6 we gave the results of atmospheric exposure tests of copper-bearing steel sheets and of pure iron sheets as made by a committee of the American Society for Testing Materials. Those tests showed greater durability for the copper-bearing steel; but our attention has been called to the fact that since culverts are buried in earth which frequently contains water that is acidulous, consideration should be given to the immersion tests made by the same society committee. Immersed in acid mine water of the Pittsburgh coal region, the committee report reads:

"In the immersion test, under the conditions which prevail at the Calumet Mine, the presence of copper would indicate little influence on the life of the specimen, and if any difference, the presence of copper would seem to give a slightly shorter life. Also, the order of failure of the various groups is decidedly changed, but it would be safer not to draw definite conclusions until we have the finished results of the various atmospheric and immersion tests."

The photographs of the test pieces indicate that the pure-iron specimens resisted the acid better than any other specimens.

Resurfacing Brick Pavements With Asphalt

Two years ago a contract was let in Oil City, Pa., for resurfacing a number of old brick streets with sheet asphalt, and the results have been excellent, according to D. A. Grant. With one exception, the brick pavements have been laid on a gravel base, and in all cases the surface was very irregular and contained many potholes. All the low places were filled with a dense asphaltic concrete, which is superior for this purpose to the ordinary binder mixture. The binder course was 1 in. thick and it differed from the ordinary binder in containing about 20 per cent of limestone

screenings. The average mix was about as follows:

	Per cent
Stone, ⅝ to 1½ in.	65
Screenings	20
Sand	10
Asphaltic cement	5

The surface course was 1½ in. thick. Mr. Grant points to the extensive use by the Pennsylvania State Highway Commission of 1 in. binder and 1½ in. surface as being sufficient proof of the serviceability of such a thin pavement. He regards the addition of screenings to the binder as being highly important, producing, as it does, a true asphaltic concrete that has greater density, rigidity and stability than the ordinary binder course. Such a binder can be rolled to any extent and suffers no distortion from 5-ton trucks.

City Planning Commission for New Orleans.—An ordinance has been passed by New Orleans, La., providing for a city planning commission of 20 members.

Road and Street Contracts Awarded During the Last 40 Months

The accompanying table shows three outstanding facts: First, that highway contracts awarded during the last half of each year have averaged only 25 per cent less in volume than those awarded during the first half; second, that there is not a month in the year without a very large volume of road and street contracts awarded; third, that each year shows a substantial gain over its predecessor.

Motor Vehicle Production in May

The U. S. Department of Commerce announces May production of automobiles, based on figures received by the Bureau of the Census in cooperation with the National Automobile Chamber of Commerce and covering approximately 90 passenger-car and 80 truck manufacturers each month.

AUTOMOBILE PRODUCTION
(Number of Machines)

Passenger Cars

	1923	1922
January	223,706	81,693
February	254,650	109,171
March	*319,638	152,859
April	*344,474	197,216
May	350,180	232,431

Trucks

	1923	1922
January	19,398	9,416
February	*21,817	13,195
March	*34,681	19,761
April	*37,527	22,342
May	42,983	23,788

*Revised.

State Line Markers for Pennsylvania Highways.—The Department of Highways of Pennsylvania is about to begin the erection of the State Line markers on all State Highways which intersect the boundary lines of Pennsylvania. These markers are to be of white reinforced concrete. They are triangular in form and the monument will be bisected by the state line. Each will bear the name of Pennsylvania and the adjoining state.

Topographic Surveys in 1922.—During the fiscal year ended June 30, 1922, the topographic branch of the U. S. Geological Survey surveyed more than 12,000 square miles of new area, exclusive of Alaska, and resurveyed approximately 1,500 square miles.

ROAD AND STREET CONTRACTS EXCEEDING $25,000 IN SIZE

	1920	1921	1922	1923
January	$ 12,204,000	$ 11,598,000	$ 14,424,000	$ 21,691,000
February	21,334,000	12,049,000	9,052,000	18,781,000
March	26,221,000	25,880,000	39,669,000	37,706,000
April	33,340,000	31,026,000	32,991,000	29,641,000
May	30,258,000	35,064,000	42,284,000	46,528,000
June	31,441,000	56,777,000	42,138,000	.....
July	29,353,000	33,943,000	26,087,000	.....
August	18,565,000	28,693,000	37,035,000	.....
September	26,537,000	23,257,000	28,884,000	.....
October	12,894,000	20,055,000	23,162,000	.....
November	12,443,000	20,751,000	20,892,000	.....
December	10,834,000	16,263,000	18,096,000	.....
Total	$265,424,000	$315,356,000	$334,714,000	.....

Note.—About 100 per cent must be added to these totals to give the grand total of highway contracts in the United States.

Bridges are not included, and bridge contracts average 15 per cent as much in value as road and street contracts. A great deal of road and street work is done by directly hired labor and is not included above.

A British View of the Fourth International Road Congress

Editorial in The Surveyor, London

We should like to be able to say—or even to think—that the Fourth International Road Congress which has lately been held in the city of Seville has achieved what had been hoped from it, or that the results have been something like commensurate with the labor involved in its preparation. We can honestly say neither; all that we are able to assert with any feeling of confidence is that the proceedings should not be wholly barren of good and should be instrumental in disseminating among those in need of it a certain amount of useful information on road-making questions that could doubtless, however, have been secured with infinitely less trouble and certainly at much smaller expense in other ways.

So far as the British road engineers who were present are concerned the Congress has been little short of futile, and there cannot be the least doubt that unless future congresses are conducted on lines which are more in conformity with Anglo-Saxon ideas it will be useless to expect that Great Britain will take any official—or for that matter, even an unofficial—part in the deliberations. When it is stated that in one of the two sections into which the Congress was divided a whole hour in a sitting of little more than two hours on the third day of the Congress was occupied in combating an obviously undesirable addendum to a certain resolution, it is not difficult to understand how little actually was accomplished during the week of the Congress.

Papers on each question, it may be explained, are prepared by the "official" delegates of the various countries. These are printed in full; but at the same time they are compressed into a more or less satisfactory—usually a most unsatisfactory—precis by the Reporter to the Section, who submits for approval a list of "conclusions" based on his reading of the contributions.

More unfortunate than anything else, perhaps, was the action taken when attempts were made by members in the body of the hall to discuss the questions brought forward; the would-be speakers were instantly and firmly suppressed by those in charge of the meeting. Such utterances as were made came almost exclusively from a select few on the platform, and as the remarks of these no doubt well-meaning gentlemen were generally otherwise than brief, and delivered at express sped, the task of the interpreter became an impossible one. As a result, interest in the proceedings quickly waned, and delegates who had gone to a meeting hoping and believing that they would be enabled to present their views on the matters under consideration drifted away from the conference room, leaving those in charge of the gathering to do their worst.

It is not at all unlikely—in fact, most probable—that an invitation will be received before long from the Italian Government to hold the next Congress in Rome. Unless very drastic alterations in the present methods of procedure are made it is quite certain that this Congress can only be a repetition of what has just come to an end in Seville—a gathering which has merely served to irritate the members of the British Section owing to the astonishing attitude of the controlling officials. Apart from this very real ground for complaint, it would be as well if in drawing up the program of the next congress a little more time were devoted to business and rather less to excursions which have only the slightest relation to the subjects under consideration, if they have any at all. It is true that Spain, and especially the southern part of the country, has little in the way of road-making to bring to the attention of visitors, but that is scarcely a sufficient excuse for setting aside such a minute portion of the time of the Congress, as was done at Seville, for the exchange of information and experiences between the road engineers of the different countries, which, after all, may be said to be the main purpose of these gatherings. It may be that the officials of the particular section to which we are referring are unaware of the strong feeling that has been aroused. If so, it may be hoped that what we have thought fit to write will be taken seriously to heart. Unless it is, and we cannot believe that it will not have the most careful attention, British delegates at the next Congress, wherever it happens to be held, will for a certainty be even fewer in numbers than they were in seville, where the attendance was unquestionably disappointing.

Bituminous Macadam at Newton, Mass.

Notes on Construction and Maintenance Given in Paper Presented Feb. 21 Before Boston Society of Civil Engineers

By EDWIN H. ROGERS,
City Engineer, Newton, Mass.

The city of Newton was a pioneer among the cities of this country in the early experimental work relating to the treatment of roads with bituminous preparations, and had established a fixed policy as to such treatment while the majority of other municipalities were still experimenting or had done but little or no work in this line.

This city is unique in undoubtedly being the only city of its population or valuation which has no paved streets as this term is usually understood by the general public, which customarily thinks of the word "pavements" as referring to wood block, stone block, cement concrete or else sheet asphalt or similar preparations on a concrete base.

This city has none of the types of pavements, except between tracks and rails of the street railway companies. The reason for this non-use of heavy pavements is that the city's population of some 50,000 is scattered over its 18 square miles of area in eleven different villages or distinct centres of population, with resulting wide distribution of traffic over a network of more or less moderately traveled thoroughfares connecting these villages and the surrounding municipalities, without concentration of heavy trucking traffic on any single road.

The more heavily travelled ways are surfaced with bituminous macadam averaging 3½-in. to 4-in. in thickness, constructed by the penetration process, using as a binder bitumen of either tar or asphaltic composition and laid on old macadam or gravel roads as a base. The lighter travelled streets are water-bound macadam or gravel, covered with a blanket coat of asphaltic oil or light tar, and sanded. The city has sufficient mileage of these two types of surfacing so that the cost of construction of the former and the maintenance of both types may be taken as representative.

Costs of New Surfacing, Repairs and Patching.—Table I shows for a period of years the amounts and costs of new bituminous surfacing, repairs and patching (exclusive of cleaning) of all the city's public ways, and the sprinkling of the larger portion of its streets. The average yardage of the roadways is about 2½ sq. yd. per lineal fot. The city has 153 miles of public ways, including 43 miles surfaced with bituminous macadam.

Maintenance Methods.—The method of maintenance on both the penetration roads and those having blanket surfacing is to fill the holes with the usual mixture of stone and bitumen. This patching is continued as needed until further work of that nature is inexpedient when a new pavement is built.

The term "sprinkling" is applied to that treatment the roads receive outside of patching maintenance, and consists usually of not more than one application per year of 45 per cent asphaltic oil or light tar covered with sand, the two types of material being used in about equal amounts. The cost of this work is assessed on the abutting property, the rate varying from 3 ct. to 5 ct. per lineal foot of frontage from year to year.

The city has naturally experimented with practically all the commercial road surfacing materials which it has appeared expedient to try, and at present uses for its penetration work bitumens of asphaltic composition to somewhat greater extent than tar preparations, as it appears that the cost of maintenance of

Table I—Cost of Surfacing, Repairs and Sprinkling

	Bituminous Macadam Re-Surfacing		Repairing and Patching		Sprinkling	
Year	Sq. yd.	Cost per sq. yd.	Miles	Cost per mile	Miles	Cost per mile
1913	49,600	$0.41	.....	.....	80	$275
1914	71,105	.55	144	$162	86	300
1915	52,092	.62	145	179	90	348
1916	54,657	.74	145	223	90	342
1917	42,771	.98	148	244	97	420
1918	.....	....	148	308	112	383
1919	14,077	2.13	149	358	112	470
1920	48,526	2.34	150	277	119	492
1921	22,166	1.93	153	263	121	454
1922	28,878	1.56	153	236	123	374

the former is somewhat less, although detailed records are not kept. Non-asphaltic oils were used to some extent in previous years on lateral residential streets, but these materials are not now employed on such work. Light non-asphaltic oils are now used only as dust layers on the paved tracks of the street railways and on such tracks as are not in a grassed reservation but are surfaced with gravel.

Street Grade Problem.—The matter of grades on our streets is a problem. In the old water-bound macadam or gravel days the roads were worn down by attrition from iron-tired wheels and horses' hoofs; now that our roads are not so worn down, patching and sprinkling with oil and sand constantly raises them. When they are re-surfaced, the new surfacing is usually thicker than that of the old, for usually a better foundation results from removing but little of the old material, while the saving in cost is an essential consideration. This gradual raising of the roadway grade destroys its proper relation to the sidewalk grade, so we find it advisable in many cases to keep our new sidewalks at a grade of sufficient height above the roadway so that a proper cross-section will result after future repairs or re-surfacing of the roadway is done to a limited extent.

Reduction in Varieties of Asphalt

In a meeting of producers and consumers of asphalt held May 28 at the Department of Commerce, the 88 varieties of asphalt used for paving purposes were reduced to 9, and 14 varieties used as brick and stone block fillers were cut to 4. Since 3 of the grades adopted for fillers are identical with 3 of those adopted for paving use, the actual reduction is from 102 to 10, or practically a 90 per cent elimination.

The meeting was the outgrowth of a preliminary conference of producers on April 24, 1923, called at their request by the Division of Simplified Practice of the U. S. Department of Commerce which is co-operating with various industries in their efforts to reduce waste by eliminating superfluous varieties. At the first meeting the producers volunteered to send to the department statements covering their individual shipments for 1922 of various grades of asphalt, as defined by penetration limits. This was done and the summary showed that 81 per cent of their 1922 shipments in 88 varieties fell within the 9 grades included in the tentative specifications of the American Society for Testing Materials. The other 19 per cent of the total tonnage was outside these grades.

After brief discussion the above action was taken. The producers were represented by delegates from the Asphalt Association, and also by representatives from asphalt companies not members of the Association. The consumers were represented by engineers and other officials from various state and city highway departments.

The conference unanimously agreed that grades of asphalt used in construction of sheet asphalt, asphaltic concrete, and asphalt macadam, pavements, and also for surface treatment should be reduced to the 9 grades having the following penetration limits:

25 to 30	50 to 60	100 to 120
30 to 40	60 to 70	120 to 150
40 to 50	85 to 100	150 to 200

In adopting these limits, it is understood that the producer will furnish asphalts with penetration equal to the mid-point in each range, a plus-and-minus tolerance from that mid-point being acceptable to all parties, but in no case shall the deviation from the mid-point exceed the limits of the grade specified.

The conference also unanimously adopted 4 grades of joint filler for various types of construction—30-50, 50-60, 60-70, and 85-100. The first is used primarily for brick pavements and does not require admixture with sand, whereas the latter three, which are identical with three of the grades adopted for asphalt pavement construction, are those which would ordinarily be used in admixture with sand to produce an asphalt grout.

This gives a total of 10 grades by penetration limits for asphalt used in construction and treatment of roads and pavements. It is the hope and expectation of all present that this reduction in variety will bring notable economies in the production, sale, and use of asphalt, all of which in due time means to the taxpayer "more miles of highway per dollar spent."

It was further agreed that this elimination should become effective in all deliveries of these materials made after Jan. 1, 1924.

Highway Engineering and Highway Transport

Report Adopted by the Society for the Promotion of Engineering Education

At the convention of the Society for Promotion of Engineering Education at Ithaca, N. Y., the Committee on Civil Engineering submitted its final report relative to highway engineering and highway transport. The committee consisted of Frederic Bass, University of Minnesota; C. B. Breed, Massachusetts Institute of Technology; H. S. Boardman, University of Maine; H. J. Hughes, Harvard University; A. H. Blanchard, Chairman University of Michigan. The report, which was adopted June 21, was in parts as follows:

The committee, will confine this report primarily to definite recommendations relative to courses in highway engineering and highway transport which should be or may be given under the supervision of civil engineering departments. This report will not include outlines of subject matter of the various courses as comprehensive reports covering outlines of undergraduate courses in highway engineering and highway transport were presented at the Second National Conference on Education for Highway Engineering and Highway Transport. Page references to the Proceedings of the Second National Conference have been enclosed in brackets following each recommendation in cases where a report presented at the conference covered the subject matter of the course or courses mentioned in a recommendation.

The Committee submits the following recommendations for your consideration:

1. In four year civil engineering curricula with or without technical electives, there should be included a required 3 hour semester course in the fundamentals of highway engineering (pages 194 to 199).

2. In institutions offering civil engineering curricula with technical electives and which are equipped to give advanced instruction in highway engineering and highway transport, provision should be made for senior students to elect courses aggregating six to nine semester hours from the following group: Theory and economics of highway improvements, highway design and highway laboratory (pages 204 to 210); highway transport economics, surveys, operations, equipment and legislation; interrelationship of highway, railway and waterway transport; and the science of traffic regulations (pages 200 to 202 and 218 to 221).

3. In several institutions, preferably located in different geographical sections of the United States, there should be offered graduate courses in highway engineering and highway transport.

4. Highway engineering and highway transport research by graduate students in civil engineering should be encouraged and developed.

5. It may be advisable for the civil engineering departments of some institutions to conduct, during the winter months, a highway engineering conference of about one week in length for the discussion of local highway engineering problems by the engineers and officials of the state, county, township and municipal highway departments, provided such conference is not otherwise satisfactorily conducted (pages 215 to 217).

Motor Vehicle Accidents in Massachusetts

During 1921 the campaign inaugurated early in 1920 to reduce accidents and make the highways of Massachusetts safter for all who use them was carried on with unabated vigor both by the police throughout the Commonwealth and the Department of Public Work. The result attained was striking, particularly with reference to the reduction in the number of persons injured. In 1919 there were 16,287 persons injured, in 1920 there were 21,182 injured, while in 1921 there were only 11,487 persons injured, notwithstanding the fact that there were 111,909 more autombiles on the highways of the Commonwealth than in 1919, and 53,016 more than there were in 1920. The principal reason for this great reduction, according to the 1921 report of the State Division of Highways, was the new regulation put into effect by the registrar on Dec. 1, 1920, making it necessary for every one to pass an examination before an original license was issued to him.

Trees Along Massachusetts Highways.—In the 17 years ending in 1921 a total of 45.607 trees had been planted on the borders of state highways in Massachusetts.

Street and Highway Lighting

Recent Developments Outlined in Report Presented June 6 at 46th Annual Convention of the National Electric Light Association

The interest of the public has been awakened to the necessity for improved street lighting and there is an increasing tendency on the part of municipalities to recognize the greater hazards accompanying automobile

Fig. 1. Dustproof Pendant With Auto Transformer for 15 or 20 Amp. Mazda Lamps in Separate Ventilated Chamber Above the Lamp.

traffic, not only by installing high intensity ornamental systems in the center of the city, but also by greatly improving the standards of lighting in the thoroughfares leading through the city.

Municipal officials are keenly alive to the desirability of improved street lighting, and this is evidenced by the discussions on the subject at the meetings of municipal associations and societies. The report of the Street Lighting Committee of the American Society for Municipal Improvements, 1922, contains a table of "Street Lighting Practice" which is noteworthy because it clearly shows a recognition on the part of municipal officials of the necessity for high intensity street lighting. The recommendations in this table for main business thoroughfares in cities of 100,000 population or larger are 10,000 to 50,000 lumens per post, and for similar streets in cities of 20,000 to 100,000 population, 10,000 to 25,000 lumens per post.

Ornamental Street Lighting.—The trend in the development of ornamental street lighting equipment has been towards higher mounting and larger units. This is logical, first, because of the acknowledged demand for increased illumination, due to modern traffic conditions, and, second, because the efficiency of the Mazda C series lamp increases rapidly with its size. Several interesting installations have been made during the past year, involving ornamental posts varying in mounting height from 16 to 30 ft., with lamps up to 25,000 lumens.

Highway Lighting.—An almost virgin field for development lies in the lighting of inter-connecting state highways. Highway lighting is a de-

Fig. 2. Enclosed Highway Lighting Unit.

velopment in which the central station is vitally interested, not only on account of the load which it develops, but also because it may be the means of taking electrical service into rural districts which could not otherwise be economically served. The automobile

associations are alive to the importance of this service and are co-operating in every possible way in all schemes for extending highway lighting installations.

Progress in 1922.—The year just closed has seen more street lighting improvements made than have been reported in any previous annual period, and there is every prospect that the coming year will see still further increases in the street lighting load.

During the year the City of Chicago placed an order for 11,800 ornamental posts to complete a scheme for placing the residence lighting distributing system underground. This is the largest individual order for ornamental posts ever placed at one time.

The Philadelphia Electric Company is carrying on some interesting experiments with 9.6 ampere series Mazda Lamps, designed to take the place of the 9.6 ampere open arc lamps at present used in many parts of the City of Philadelphia.

The past year has seen a marked increase in the use of automatic cutout hangers for pendant Mazda Lamps, and a general recognition that such devices are desirable, not only as a safeguard to the "trimmers" but also as a means whereby the lamps may readily be lowered for cleaning. While the code demands the use of absolute cutouts on arc lamps operating on series circuits, an exception in the code has permitted the operation of incandescent lamps on series circuits without absolute cutouts. The manufacturers of this device report more sales in cutout pulleys during the year 1922 than in any previous year.

Street Lighting Glassware.—The quality of enclosing glassware used in a street lighting unit has an important bearing on the efficiency of the unit and on its appearance. There has been an evident demand on the part of the public for a sparkling effect in street lamps which would impart life and brilliancy to the appearance of the streets without undue glare. This has been proved by the greatly increased use of alabaster rippled globes during the past year. A valuable addition to street lighting glassware will be found in the new rectilinear glassware. The surface of this glassware presents a number of rectangular protuberances which tend to diffuse the light without materially altering its direction. It is supplied in clear crystal or slightly flashed opalescent. The latter gives the most

Fig. 3. Viaduct Lighting, McLemore Ave. Viaduct, Memphis, Tenn.

pleasing results, softening the light and giving a maximum of "eye comfort" to the observer.

The trend of development in the use of panelled lanterns for street lighting units has been continued, and many cities have found the claims for lower maintenance costs, due to lesser glassware breakage, fully justified. Several types of lantern units for which replacing panels may be purchased from local glass dealers at low cost are now available.

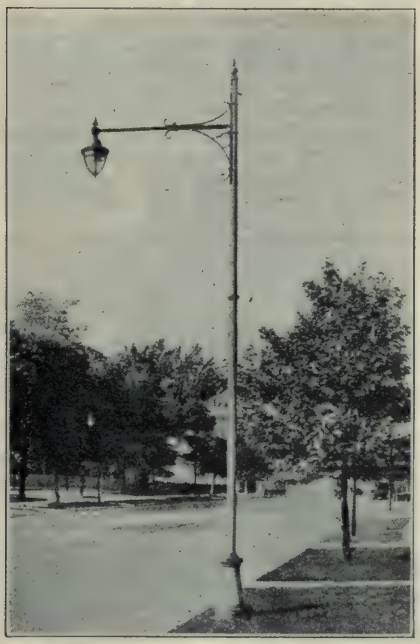


Fig. 4. Lighting Unit for East Cleveland, O., Residence District.

A new type of bowl refractor for pendant units has been introduced. This is known as the "Superlux" and its characteristics are such as to build the light rays laterally, while at the same time adequately illuminating the area adjacent to the unit. Experiments are also being made in the design of an a symmetrical refractor which will build up the light longitudinally while only allowing a small portion of the light to be directed across the street.

Ornamental Post Tops.—During the past year several new designs of ornamental post tops have been added to those already available, some of which are illustrated. The light distribution in these units is controlled by upper and lower parabolic reflectors, designed to give a maximum distribution 20 deg. below the horizontal, and thus the necessity for refracting glassware is eliminated. The reflectolux system of light distribution is particularly adapted for ornamental post lighting where the spacing varies between 50 to 100 feet.

Pendant Units.—There have not been many developments in pendant

Fig. 5. Lighting System in Residence District of Ephrata, Pa.

street lighting units during the past year, and the types at present available appear to be well standardized. One development worthy of mention here has been made in the auto transformer type pendant for 15 and 20 amp. lamps. A unit has been designed (Fig. 1) in which the auto transformer is located in a separate ventilated chamber above the lamp, thus enabling the lamp to burn in a separate chamber from the transformer; the partition between the lamp and transformer chambers prevents the rising currents of hot air reaching the transformer. This construction renders the unit dust and bug proof when equipped with a closed bottom refractor or an enclosing globe well seated on a felt gasket.

A new totally enclosed Highway Lighting Unit is shown in Fig. 2. In this unit the lamp is placed at the focus of an inverted parabolic reflector which re-directs the light rays vertically downward upon two refracting prismatic surfaces, and thence to the roadway in two directions only. It is claimed for this unit that it is "dust-proof" and that its initial efficiency is maintained for long periods without cleaning.

Arc Lamps.—Improvements in luminous arc lamps include the use of rippled glass globes, more effective reflecting devices, and electrodes of longer life and higher efficiency. Compressed electrodes of square or oval shapes were found to give much greater life than previously secured with proportionally diminished trimming costs.

Viaduct Lighting.—An important

Fig. 6. Boulevard Lighting at Lansing, Mich.

Fig. 7. Night View at Lima, O., a Good Example of Efficient Street Illumination.

phase of street lighting is the efficient illumination of viaducts and bridges, and an installation recently completed on the McLemore Avenue Viaduct, Memphis, Tenn., is noteworthy. This installation (Fig.3) shows a pleasing combination of cast iron bracket and pendant lantern with the concrete structure of the viaduct. In this in-

Fig. 8. Ornamental Steel Pole and Brackets With Ornamental Pendants at Newark, O.

stallation multiple circuits are used because of the desirability of keeping the series circuit off the viaduct. The multiple circuit is controlled by a remote control switch connected to the series circuit and so arranged that when the series circuit is turned on at the plant, it energizes the magnet coil of the switch and causes the switch to close on the primary side of a small distribution transformer which feeds the lights on the viaduct. By this arrangement the viaduct circuit requires no special attention, and goes on and off automatically at the same time as the main street lighting circuit.

Interesting Lighting Installations of the Past Year.—With the ornamental street lighting equipment at present available, the planning of an improved system for a business district is a fairly simple matter; but, owing to the dense foliage which generally exists on residence streets, this class of lighting presents some difficulties. The problem may be solved either by the use of bracket type units supported on tall poles of sufficient height to bring the light source well beyond the foliage line, or by ornamental posts with the light source mounted below the foliage line. Each system has its application, and the type selected must be determined by local conditions.

An interesting residential district installation was made during the past year at East Cleveland, O., which is worthy of mention. Here the units (Fig. 4) are mounted on brackets supported on steel poles 16 ft. above the sidewalk and projecting 6 ft. over the roadway. This arrangement brings the light source well beyond the foliage line. The unit is equipped with a dome refractor within a rippled glass globe, which permits of a spacing of 280 ft. staggered resulting in a high degree of illumination on the road surface and sidewalk. This installation is one of the few modern street lighting system in which multiple circuits are used. It was found more economical when planning this system to connect the residence street lamps to the 115 volt house lighting secondaries located along the rear lots through underground services brought out along the side lot lines. A time switch is used to control the lamps supplied by the secondary in each block.

A typical residence street in which ornamental posts are used is shown in Fig. 5. In this installation the posts are spaced 100 ft. apart, and each is equipped with diffusing glassware mounted 10 ft. 6 in. above the sidewalk. As will be seen from the photograph, the light source is placed below the foliage line and a good illumination is obtained on roadway and sidewalk. This installation is operated on the usual series system.

An interesting installation has just been completed at Lansing, Mich.

(Fig. 6), which is part of a plan for re-lighting the entire city with an ornamental system. On the main business streets, two light standards, 20 ft. to the light source, with 10,000 lumen lamps will be used. Secondary business streets will have single light standards, 15 ft. to the light source, with 10,000 lumen lamps, and the boulevards, such as are shown in the illustration, will have 13 ft. standards with 4,000 lumen lamps. The minor residence district will be equipped with 2,500 lumen lamps, 11 ft. 6 in. to the light source, and all units will be provided with a means whereby the next size larger lamp may be substituted when increased traffic conditions demand such change.

Another installation, which is noteworthy because it emphasizes the tendency on the part of municipalities to treat ornamental street lighting improvements as part of a scheme to beautify the city as a whole, has been completed at Lima, O. (Fig. 7). The installation covers an ornamental system for the entire city, and the height of post and size of lighting unit have been carefully graduated with regard to the relative importance of the streets. A minimum of 2,500 lumens is used in the residence districts, increasing to a maximum of 10,000 lumens in the main business streets and the public square. The impression of the graduated and harmonious illumination is very pleasing and the stranger is able immediately to distinguish the importance of the various streets by the intensity of illumination.

Newark, O. (Fig. 8), is one of the first cities to take advantage of the new 25,000 lumen Mazda "C" Lamps, and an installation is being made with the lamps mounted 30 feet above the sidewalk. Special pendants have been designed, equipped with large Holophane Bowl Refractors arranged to give a maximum illumination at 15 degrees below the horizontal. The installation is highly efficient and the results obtained, pleasing to the eye, as the brilliant light source is mounted sufficiently high to take it out of the range of vision of the pedestrian or the vehicle driver.

Natural or Artificial Sand-Clay Mixtures for Road Surfacing

At the 26th annual meeting of the American Society for Testing Materials, June 25-29, at Atlantic City, N. J., Committee D-4 on Road and Paving Materials, submitted a "proposed tenative" specification for natural or artificial sand-clay mixtures for road surfacing. Criticism of this tentative specification is invited by the committee and should be directed to Prevost Hubbard, Secretary, 25 W. 43rd St., New York City. The tentative specification follows:

The sand-clay shall be composed of either a naturally occurring or artificially prepared mixture of hard, durable, preferably angular, fragments of sand together with silt and clay with or without gravel, and shall be free from an excess of feldspar or mica.

When tested by means of laboratory sieves and screens the material shall conform to the following requirements as to grading:

Passing 2-in. screen	100 per cent
Passing ¼-in. screen	30 to 100 per cent

The material, if any, retained on the ¼-in. screen shall be uniformly graded from the maximum size present to ¼-in.

The material passing the ¼-in. screen shall conform to the following requirements:

Total sand	50 to 80 per cent
Sand retained on 60-mesh	30 to 60 per cent
Silt	5 to 20 per cent
Clay	15 to 30 per cent

The tests for the mechanical analysis of the sand, clay, natural sand-clay or topsoil mixtures shall be made in accordance with the Tentative Method of Mechanical Analysis of Subgrade Soils (Serial Designation: D 137-22 T), except that the determination of the percentage of suspension clay may be omitted and the percentage of total clay may be calculated by difference as follows:

100 — (Percentage of Sand + Percentage of Silt) = Percentage of Clay.

The Connecticut Investigations of Highway Traffic

Some Results of the Censuses Carried Out by U. S. Bureau of Public Roads and State Given in Paper Presented Feb. 14 at 9th Annual Michigan Conference on Highway Engineering

By GEORGE E. HAMLIN,
Maintenance Engineer, Connecticut State Highway Department

The solving of highway problems by the analysis of data obtained from comprehensive and continued studies of traffic conditions is now recognized as necessary for the proper construction and financing of any good roads program. Investigations have been in progress in various states with a view of determining the economic road which will in cost, construction and maintenance give the maximum service to the average tax payer. Sections of experimental road have been built which have been tested to destruction in order to determine their sustaining characteristics for various types of traffic. From these experiments it is desired to determine the type of road which will best economically fit a determined traffic condition. There, therefore remains the determining of the character and amount of traffic which any particular highway will be required to carry. For this purpose traffic censuses have at various times been instituted in many localities extending generally over a comparatively short period and in many cases only over peak periods, from which an attempt has been made to develop a curve of increase, both in quantity and weight, by which the necessary qualities may be determined for the estimated life of any particular road surface.

Results of Maine Traffic Census.—The Highway Commission of the State of Maine inaugurated in 1916 a traffic census which at its inception was taken at about 12 stations on the state highway system. This census has been taken each year, the number of stations being increased as found necessary to develop the results. In the year ending June 30, 1922, traffic was counted at about 50 locations and extended over a period of seven successive days. This count is generally made during the last week of August or the first week of September and takes in a daily period of 12 hours from 7 a. m. to 7 p. m. The count is divided into north or south and east or west traffic, further divisions being made into horse-drawn and motor vehicle traffic with several further subdivisions of each class.

At one of the stations near Portland the 1922 census developed 99.8 per cent of motor vehicles and .2 of 1 per cent of horse-drawn vehicles.

At this same station in 1916, 97 per cent of the vehicles were motor vehicles with 3 per cent of horse-drawn vehicles. In 1916, 7,790 motor vehicles were counted and 258 horse-drawn vehicles. In 1922 there were 26,012 motor vehicles and 63 horse-drawn vehicles. While this proportion does not hold true at all stations throughout the state, due to the character of the country, in the great majority of cases the percentage of motor vehicles is 97 per cent or more.

The Commission notes in its report "the traffic census not only shows which roads are of most importance to the public, but the information also is an indication as to the type of surface which must be provided at the locations under consideration."

The Purpose of Traffic Counts.—Mr. Nelson P. Lewis in charge of the physical survey. Plan of New York and Its Environs makes the following comments in relation to traffic surveys:

"I consider that the chief purpose of traffic counts is to determine where additional traffic capacity should be provided in one or more of the following ways:

(a) Widening existing roads;

(b) Constructing additional main roads;

(c) Segregating slow and fast moving traffic, as through the provision of motor truck highways;

(d) By-passes around congested centers.

The traffic to be provided for is that desiring to use the road at the busiest time of day so that the number of vehicles passing during the heaviest hour, or quarter hour, will give some indication of the need of relief, but this may be misleading in that a small number of vehicles may be due to relatively slow speed, on account of mere numbers, or to the presence in the line of a large proportion of heavy vehicles of low speed and flexi-

bility. A complete diagnosis cannot be made unless the census includes a record of the speed, flexibility, and degree of obstruction offered by the vehicles, while the wheel loads will afford a fair measure of the destructive character of the traffic.

Proposed methods of observation and analysis should be so worked out and put in such logical and simple form that they will not deter states or other political units where funds for this sort of work are scant or where its importance is not yet fully realized, from undertaking any traffic analysis.

The value of observations will be proportioned to their completeness and thoroughness, but even if they are not exhaustive they will have considerable value if the most important, even though the simplest details are taken up first. Where saturation already exists there is little to be gained by extensive observations. Comparisons may be made to determine the relative capacity at certain contracted points, or "bottle necks," compared with that at other points where such conditions do not exist, provided the latter are not within the influence of the contraction, or "bottle neck," with which comparison is to be made.

Traffic Survey in Minnesota.—In the State of Minnesota in the year 1921 it was arranged for the state maintenance force to carry a continuous traffic survey on the more important roads throughout the whole season, taking one or two days each week so that the seasonable variation in traffic could be enumerated. In this census four general classes of vehicles were noted: Passenger cars, transportation lines, miscellaneous trucks and horse-drawn vehicles. The passenger cars were further divided into heavy and light models; also foreign and Minnesota cars were noted. The number of passengers in each car was taken in all cases.

Mr. John H. Mullen, Chief Engineer, says that this traffic survey is more or less superficial and that plans should be evolved which will not only show the character and change in volume of traffic from year to year, but that maps should also be prepared showing the origin and destination of various kinds of traffic, from which can be ascertained in a measure the future development of traffic in a given community.

Early Traffic Censuses in Connecticut.—The State of Connecticut during the past few years has carried on traffic censuses for short periods of time with a view of determining the natural increase from year to year on the various highways comprising the trunk line system. The first censuses were taken at different strategic points along the highways throughout the state, being carried on in many cases for a continuous 24 or 48-hour period, and generally at the time of the year when it was estimated the average traffic would be found.

The data obtained, however, were extremely conflicting and did not necessarily show the logical growth to be expected for a period of years. To obtain peak loads which must of necessity be carried by the highways, a census was made two years ago on seven main roads in the vicinity of New Haven on the occasion of the Yale-Princeton football game. This census extended over a period of 12 hours, from 8 a. m. to 8 p. m., only the number of vehicles and their directions noted. No attempt was made to determine the origin or destination of the traffic outside of New Haven. During this period 26,016 vehicles were noted, the period of greatest congestion being on the Boston Post Road west of New Haven on the direct New York highway, between the hours of 5 and 6 p. m., when 1,619 vehicles were enumerated passing the station, this being an average of one vehicle every 2¼ seconds. It is understood that this was an extreme peak condition but if the traffic is to be cared for on public highways, such peaks must be taken into consideration in designing both the width of the highway and the character of the surface.

The Present Connecticut Survey.—In 1912 in connection with the Bureau of Public Roads, traffic censuses were taken at the New York State line in Greenwich and at the Massachusetts State Line on the Hartford-Springfield Trunk Line for a two weeks period. Each vehicle was stopped and the driver questioned in regard to origin and destination of trip and in the case of trucks, the commodity weight, tire condition, etc., was obtained.

Many interesting facts were brought to light which seemed to require further study before being accepted as basic data. Arrangements were therefore completed with the Bureau of Public Roads and in September of last year a system of 56 stations was laid out at strategic points throughout the state where periodically a party was detailed to

obtain the information required to develop the average yearly traffic.

To carry out this survey of traffic and obtain the detailed information desired, three motorized parties of five men each were established and at eight of the stations selected with reference to traffic conditions, pit platform scales of 25-tons capacity were established to obtain the necessary truck weight requirements. Two of the parties known as extensive parties work entirely independently of each other. Information is obtained by them as follows:

Passenger cars:
Station at which information is taken.
Day and hour on which information is taken.
Direction in which car is traveling.
State issuing car license.
Make of car.
Type of car, whether roadster or touring.
Number of passengers in car.
Nature of trip being made, whether business or pleasure.
Origin of trip.
Destination of trip.
Trucks:
Station at which information is taken.
Day and hour on which information is taken.
Direction in which truck is traveling.
State issuing truck license.
Make of truck.
Capacity of truck.
Commodity carried.
Number of trips made per week.
Length of time required to make trip.
Length of trip.
Destination of trip.

How the Census Is Taken.—Of the five men in each extensive party, four handle passenger car traffic. This work is generally divided so that two men obtain the information in regard to north or east bound cars and two in regard south or west bound cars. In each case one man acts as observer and the other as recorder. The observer stands on the road, stops the cars and calls out the information to the recorder who enters this on the prepared sheets or cards.

The fifth man obtains truck information and must take care of traffic in both directions, doing both his own questioning and recording. A card simlar to the passenger car card is made out for each truck.

In order to prevent congestion and to keep at least half of the road open at all times, the passenger car men have stations at least 200 ft. apart. It has been found that traffic is seriously impeded where all questioning is done at the station itself. Very little trouble has been encountered at most sations in detailing one man to obtain truck information. At a few sations in the state where the truck traffic is abnormally heavy at times, it is customary to transfer one of the passenger car men to help obtain the truck information. Additional men are also assigned to stations where passenger car traffic is unusually heavy to avoid any congestion or serious slowing up of traffic through the operation of the census.

Printed signs 3x4 ft. are placed alongside of the road so that the driver is warned in approaching the census station of the reason of the questioning.

The prepared cards are sent to Washington where the information shown on the stub is punched on the card which is then ready for placing in the tabulating machine.

The third party is known as the intensive party and operates only at points where platform scales have been installed. This party occupies each station for a period of six consecutive days and the amount of information required is such that the listing of the data has been divided between two recorders.

The first recorder lists the following:

Station at which information is taken.
Day and hour on which information is taken.
State, and number of truck license.
Name of truck owner.
Name of party shipping goods and city and state from which they have been shipped.
Name of party receiving goods and city and state in which they will be received.
Class of shipment whether Pick-up to Delivery, Terminal to Terminal, Pick-up to Terminal, or Delivery to Terminal.
Commodity carried.
Nature of packing and crating, whether goods are being carried loose, boxed, crated, baled, etc.

The second recorder lists the following:

Station at which information is taken.
Day and hour on which information is taken.
State and number of truck license.
Make of truck.
Number of trips made per week.
Capacity of truck.
Length of time required for trip.
Whether truck is loaded or empty.
Width of truck body.
Net weight.
Gross weight.
Front axle weight.
Rear axle weight.
Type of tires and width of tires on pavement under load both front and rear.
Depth of tires ccannel to pavement under load.
Width of tires channel to channel.

Care is taken in listing the information so that the same truck appears upon the same line in both sheets. This is afterwards checked up before the sheets are sent to Washington by comparing the license numbers listed on the corresponding lines. The time required for obtaining information and weighing the truck varies from 1-3

minutes; the average time being probably 1½ minutes. The first recorder questions the driver in regard to origin, destination, number of trips, etc. The second recorder receives the truck weight from the scale man and truck measurements from an additional observer. These items he lists on the proper sheets in accordance with the direction of traffic.

Tire widths are obtained by causing the truck to pass over a strip of white cardboard and measuring the track made. Channel widths are obtained by means of a pair of callipers.

Use of Scales Reduces Truck Overloading.—The eight sets of scales were primarily constructed for use in the traffic census, and the average cost of each completed scale, including scale house, self-reading dial, lighting system, etc., was $2,532. While this would seem to be a large investment for census purposes, these scales are also used in the State of Connecticut by the State Police Department for measuring overloads and overweights on trucks. The law forbids the loading of any truck beyond its registered capacity or a total weight in excess of 25,000 lbs. which may be reduced if found necessary at certain seasons of the year by order of the Highway Commissioner. It has been found that since the installation of the scales, overloading has been reduced and as a consequence that fewer breaks in the surfaces of the more impermanent types of road have resulted during the early spring.

The 56 stations in the state have been divided into eight districts, each extensive party completing one district in a week so that by working seven days a week and spending one day at each station, each party completes a district in one week and a cycle of the state in eight weeks. The intensive party travels from one to another of the intensive stations, occupying each station for six successive days and making a cycle of the state in eight weeks. This party does not operate on Sundays on account of the small amount of truck traffic on that day. Care has also been taken to route parties so that no more than one of the three parties is in the same district at the same time. This outline of work was carried on during the summer and fall months. With the coming of winter the large decrease in the passenger car traffic and the icy condition of the roads caused the abandonment of the practice of stopping and questioning the drivers of the passenger cars. The extensive parties were then cut down to two men each and an hourly count of passenger cars was made.

Full information obtained in regard to truck is still being obtained. The intensive party, however, has been reduced to three men. Two additional men divide their time among the three parties when any one of these is located where travel requires additional observers.

The total cost of the census from Sept. 11, 1922, to Jan. 27, 1923, including the cost of the three cars used in the work, but no part of the cost of the scale installation, has been about $15,000, $3,000 of this amount being estimated as paid by the Bureau of Public Roads for the salaries and expenses of three government observers.

During the four months of operation various minor difficulties have arisen which have been adjusted to fit the particular condition.

It has been common practice to locate a station at the junction of two roads. This is satisfactory in most cases, but an exception is found at Station No. 19 at the Rhode Island State line in Westerly. The junction here occurs in a congested business district where a large proportion of local traffic was found. Arrangements were therefore made to cover each road separately and an additional man was detailed to the party for this purpose.

The Chief of the Survey visits each party at least once and frequently twice each week, collecting from them the cards and sheets which have been filled out, and adjusting any difficulties which may have arisen in handling the work. These cards and sheets are shipped to the Bureau of Public Roads in Washington, where operatives punch each card with the information shown on the stub. These cards are then ready for passing through the tabulating machine.

Some Results of the Census.—A comparatively small amount of tabulation at the present time has been made ready for publication. Possibly the most interesting chart as yet furnished is that which shows the average daily movement of motor trucks on Connecticut highways between Sept. 11 and Dec. 3, 1922. This chart shows an average of about 750 motor

trucks per 24-hour day on the Boston Post Road between the New York State line at Greenwich and Bridgeport. From Bridgeport through New Haven to Hartford and from Hartford to the Massachusetts line south of Springfield, the average number of trucks approximates 350 to 400 per 24-hour day. In the vicinity of Waterbury in which are manufactured large quantities of brass products and which to the north and south for a considerable distance is a succession of manufacturing cities, the chart shows 350 motor trucks per day. About 100 of these constitute local traffic, the remaining 250 being nearly equally divided between the New Haven and Bridgeport roads. Inasmuch as the truck traffic determines to a large extent the character of the necessary road surface, it is fair to assume that the width of line showing the number of trucks per day is directly proportional to the need of a hard surfaced highway.

During the period from Sept. 12 to Dec. 2, 1922, the estimated gross truck tonnage movement on Connecticut highways was 495,357 tons with a net weight of 188,812 tons. Of the latter amount, about 112,000 net tons were carried on trucks with Connecticut licenses, and 77,000 net tons on trucks with foreign licenses, New York and Massachusetts trucks carrying respectively 35,000 and 32,000 net tons; New Jersey, 5,380 net tons; Rhode Island about 3,000 net tons and 1,5000 tons from miscellaneous states.

These figures would seem to show that more than 40 per cent of the net truck tonnage operating on Connecticut highways is carried in trucks with foreign markers paying no fee for the privilege of operating upon Connecticut highways.

Average Mileage and Vehicle Weight.—From data obtained a chart of comparison of average mileage with average gross weight per vehicle has been drafted. This would tend to show that the average mileage and the average gross weight per vehicle is proportional. Of Connecticut trucks, the average gross weight being about 9,700 lbs., the mileage averages 30. New York trucks with an average gross weight of 10,700 lbs. shows an average mileage of about 40. Rhode Island and Massachusetts trucks with an average gross weight of about 12,000 lbs. show an average mileage of 75, while New Jersey trucks with an average mileage of 110 show average gross weight of 13,500 lbs.

Charts have been prepared for each of the intensive stations showing the truck traffic density by hours.

These charts show the number of vehicles passing each station during each of the 24 hours and show points of density in the morning and afternoon which are evidently directly related to the distance of the station from the point of origin of haul.

At Greenwich, at the New York State line, the hourly truck traffic shows an increase from 32 between the hours of 6 and 7 a. m. to 57 between 12 and 1 to 40 trucks, increasing again between 1 and 5 p. m. to between 55 and 60 trucks per hour, dropping between 6 and 7 p. m. to 27 trucks and between 3 and 5 a. m. to 13 trucks.

Average Length of Truck Haul.—To a certain extent the average length of haul can be computed from these charts by taking half the time between the peaks and multiplying this by the average rate per hour per truck. The lag during the noon hour is very evident on most of the charts.

The chart of average truck haul by capacities taken from the records of the Greenwich station shows that tonnage value of the material is nearly proportional to the average haul in miles. On trucks of 3-4 tons capacity products of mines were hauled an average of 21 miles; products of forest an average of 38 miles; products of agriculture an average of 48 miles; products of animals, an average of 54 miles; manufactures and miscellaneous an average of 75 miles. This tends to prove the claim of the railroad companies that the motor truck has taken away to an appreciable extent the hauling of the high grade, high class commidities, leaving to the railroad only the lower class of freight of large tonnage and low receipts.

In the period from Sept. 11 to Dec. 3, 1922, it is estimated that 33,631 net tons of freight were transported from New York City to Connecticut points. It is interesting to compare the total net tonnage delivered in various cities with the total mileage covered.

The following table gives the destination, tonnage, percentage, and dis-

tance from New York as a basis of comparison:

	Tons	Percentage	Distance Miles
Greenwich	2,216	7	30
Stamford	7,247	22	35
Danbury	1,011	3	63
Norwalk	3,684	11	44
Bridgeport	7,086	21	58
New Haven	4,853	14	75
Waterbury	1,435	4	90
Hartford	1,186	3½	113
Vicinity of New Haven	2,258	7	74

No attempt has been made as yet to consider the population of these cities and towns as a basis for approximately determining the tonnage of freight to be moved for various distances and it is not known that such a formula can be established without considering in addition the industries of the city receiving the freight.

It is possible, however, that there is a comparative relation existing which can be used as a basis for determining the probable amount of freight traffic over any particular road for any given distance.

The census now in progress beginning Sept. 11, 1922, has not developed the high peak of traffic which will be encountered at some of the stations during the summer months. On the previous census taken at Greenwich on Sunday, July 9, 1922, between the hours of 10 a. m. and 8 p. m. 6,930 passenger cars, 48 trucks and 60 miscellaneous vehicles passed the station. In the census now in progress, a maximum number of passenger cars counted on any one day was at the Greenwich station on November 11, when 3,252 passenger cars and 663 trucks were enumerated, between the hours of 11 and 8 p. m.

Seasonal Variation in Traffic.—Comparison has also been made to determine the seasonal variation in traffic at the various stations. The information already collected would tend to show that while passenger car traffic decreases notably during the winter period, truck traffic remains fairly constant throughout the year, decreasing only a small percentage during the winter months.

At Station 46 on the Hartford-Springfield Trunk line 1,135 passenger cars and 201 trucks passed the station in nine hours in the latter part of October. The count taken about January 1 showed 242 passenger cars and 191 trucks. During the same period at Station 8 near Bridgeport, on October 20 there were counted 1,811 passenger cars and 499 trucks; on January 25, 572 passenger cars and 315 trucks.

At Station 6 at Greenwich on Sept. 16, 1,718 passenger cars were enumerated while on Dec. 23, 2,470 cars were counted. This is not comparative, inas much as the large number of cars in December is due, without doubt, to the near approach of the holiday.

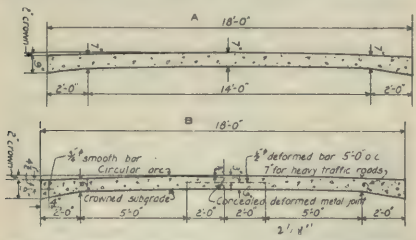
At Station 38 near Meriden on Sept. 18, 1,520 passenger cars and 261 trucks were enumerated; on Jan. 23, there were 186 passenger cars and 190 trucks.

It is not expected that the information now obtained will necessarily be final or that the conclusions given may not be subjected to change, when additional data has been collected. It is intended to carry on the survey now in progress for a sufficient period to determine definitely what may be expected by the road designer and builder for his future guidance. This does not mean that it will be necessary to inaugurate each year an extended highway traffic census for long continued periods of time. After the seasonal variation is determined by the census now in progress, it is hoped that from counts for short periods of time at different seasons of the year may be determined the yearly increase of both weight and traffic so that curves can be platted to show what may be expected at any definite future period.

It is believed that the traffic census will be of great value to the student of transportation as well as to the road builder. The results obtained will give the value of the truck as a transportation unit in connection with the study of transportation as a whole and particularly as applied to transportation by railroads. Committees are at work in connection with the problem of transportation to determine where the railroad and truck are in competition and to co-ordinate, if possible, the various activities so that all transportation methods, having in mind railroad, trolley, waterway or truck, may have defined economic areas of activity. All agencies should help in the quick and efficient delivery of commodities, rather than for the one to assume functions which can best economically be carried on by another.

Concrete Pavement Sections With Thickened Edges

The thicker-at-the-edges design for concrete pavement, though it has been used in a modified way in the earlier days of concrete road building, has only recently been accepted as an important improvement in concrete pavement design. Since its first extensive



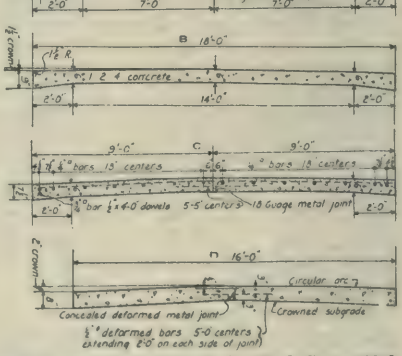
Typical Paving Sections. A—Granville Island, Vancouver Harbor. B—Standard Section Illinois Division of Highways.

use in Maricopa County, Arizona, the thicker-at-the-edges section has proved its worth in the Pittsburgh Test Road; its necessity was demonstrated in the Bates Experimental Road and it has been adopted, with slight variations, as the standard design in several state and county highway departments. We are indebted to the Concrete Highway Magazine for the following particulars regarding this new feature.

Wayne County Pioneer in Heavier Edge Construction.—Probably the first concrete pavements with heavier edges were built in Wayne County, Michigan. The thickened edge was in reality an inverted curb which was placed to provide additional strength at the edge where the corner was rounded to make it easier for vehicles to get on and off the pavement. Other examples of the use of inverted curbs or beams under the edges of concrete pavements were found in California, in Cuyahoga County, Ohio, and Chautauqua County, New York. In all of these cases, the additional support at the edges was provided to meet some particular condition, such as an especially insecure subgrade. They constituted a special precaution and were not considered necessary under ordinary conditions.

The general trend in standard road sections was in the opposite direction—thicker at the center than at the edges. This was probably caused by the desire to get away from the crowned subgrade which was more difficult to construct accurately and which was thought by some engineers to be responsible for the formation of longitudinal cracks. But it was soon found that one of the most prolific sources of trouble was the tendency of concrete roads too narrow for the volume of traffic to be served to break at the edges and at the corners of slabs. Added strength given to the center of the slab seemed misplaced in view of the greater volume of traffic forced to travel near the edges.

Concrete Pavements in Maricopa County.—Maricopa County, Arizona, was the first to undertake, on a large scale, the construction of concrete pavements having thickened edges. The section adopted became known as the Maricopa Section and was selected as standard for that county's 309-mile concrete highway system which was begun in 1920. How well the Maricopa Section served traffic is shown by a recent thorough inspection. There was an almost complete absence of corner breaks in spite of the fact that as soon as the pavements were opened to traffic, they were used by heavily loaded material trucks weighing about 12 tons which trav-



Typical Paving Sections. A—Utah State Highway Commission. B—Maricopa County, Ariz. C—State Highway No. 40, Tarrant County, Texas. D—Delaware State Highway Department.

eled on the extreme edge of the pavement.

The Pittsburgh Test Sections.—While the Maricopa County pavements were under construction, a test road containing thirteen different designs of concrete pavement was being constructed at Pittsburgh, Calif. Four sections were constructed with thick-

ened edges and one of these was of the Maricopa design. The road was subjected to intensive traffic so that the behavior of the various designs could be studied and compared. It was found, among other things, that the edges of the slabs appeared to be the most vulnerable places and that most of the breaking started at the edges or the joints. Sections with thickened edges made the most favorable showing in spite of the fact that these were built without reinforcement.

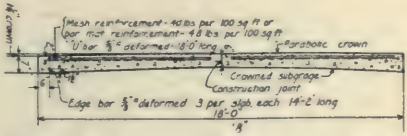
The Bates Road Tests.—Tests made at the Bates Experimental Road near Springfield, Ill., under the direction of the Illinois Division of Highways, substantiated the findings at Pittsburgh. In the Bates Road sixty-three sections of various types and designs were subjected to traffic and the results carefully studied. Though there were no sections with thickened edges in the Bates Road, the test showed conclusively the need for greater strength at the edges. Commenting on this feature, Clifford Older, Chief Engineer of the Illinois Division of Highways, said: "Rigid pavements having a uniform thickness or edges thinner than the center are greatly unbalanced in strength and will fail along the edges long before the wheel loads are reached which will cause the destruction of other portions of the slab. Although fifty of the original sixty-three sections of the Bates Road either were completely destroyed, or sustained decisive local breaks, not one case of serious partial or complete failure of a rigid section occurred that was not directly due to the lengthening and widening of one or more small broken corner areas.

"The comparative absence of destruction along the north edge of the road where the wheels, except during the first and a portion of the second increments, traveled three feet from the edge is striking. * * * Increasing the edge strength of pavements of ordinary width should therefore be of first importance in design."

On the strength of these experiments, backed by the results at the Pittsburgh Test Road, the condition of the Maricopa County pavements and theoretical computations, the Illinois Division of Highways changed its standard concrete pavement section from a 7-in. uniform thickness to the cross section shown in the accompanying illustration, having a thickness of 9 in. at the edges and tapering to 6 in. 2 ft. from the edges. For roads to carry especially heavy traffic, or for bad subgrades, the central part of the slab will have a thickness of 7 in., with 9-in. edge.

To verify these conclusions, five new sections of concrete were added to the Bates Experimental Road. Four of these have edges thickened to 9 in. with 5 and 6-in. centers, the other being the old standard section of 7-in. uniform thickness. Truck traffic is now testing these new sections and results to date have convinced Mr. Older that the adoption of the new design was justified.

The New Illinois Sections.—It is also significant that the new Illinois standards require the same mixture as required for concrete roads (1:2:3½), and identical cross-section for concrete



Typical Cross Section New York State Highways.

bases for asphaltic tops, including the marginal rods and center joint. For bituminous filled brick, the concrete base is specified to be 6½ in. thick, 1:2:3½ mix, marginal rod, center joint, with marginal curb 8 in. wide, 4 in. deep, monolithic with the base. For monolithic brick, the base, including the mortar bed, is 5 in. thick, but curbs, marginal rods and center joints are not required.

Since Illinois has changed to the thicker-at-the-edge section, other state and county highway departments have adopted similar designs. Accompanying illustrations show cross sections now being used by New York, Delaware, Utah, Tarrant County, Texas, and by the Vancouver (B. C.) Harbor Commission. Other highway departments using similar designs are the state of Virginia, the District of Columbia and Caddo Parish, La. While the individual designs of these sections differ in their details, all of them make use of the newly accepted principle that the edges of the slab require greater thickness than the center.

Road Maintenance Methods in Canadian County

How Toronto and York Highway Commissions Maintain Earth and Gravel Roads, Described in Paper Presented June 12 at Annual Convention of Canadian Good Roads Association

By E. A. JAMES,
Consulting Engineer, Toronto, Ont.

While we believe in maintenance, yet we must point out that adequate maintenance is frequently a waste of public funds. The road builder and and the road financier must carefully balance annual maintenance against annual depreciation and the carrying charges of constructed roads. Otherwise you will find that adequate maintenance is costing twice as much as proper construction.

We have in mind a macadam highway which was properly constructed as a macadam highway but which today is costing $2,500 per mile per year to maintain. It would be much better for that municipality to construct a higher type of pavement and thus get good service at much less expense. We take it that when speaking of maintenance we have in mind the maintaining of roads that have been properly planned and constructed having regard to local conditions and traffic. One can hardly speak intelligently of adequate maintenance unless there has first been adequate construction.

Organization and Work of Maintenance Force.—Originally our roads were divided into beats and we had a patrol system. The number of men varying with the type or road and character of traffic. We found, however, that the type of man who was content to patrol the roads doing the necessary repair work, required too much direction, and also that a man working alone or even with one companion became as years went by less efficient, due we think to the lack of competition. In later years we have grouped four or five patrol parties under one foreman, a man of experience and with some judgment so that now our maintenance work is carried out by parties of five or six men equipped with one ton truck, tools, materials, etc.

The work of these maintenance parties not only includes the repairing of small holes, cleaning ditches and water ways, but also on the gravel and macadam roads, the elimination of ruts and the preventing of ravel by the application of bituminous carpet coats from time to time. In some instances bituminous wearing surfaces are maintained and repaired by the use of cold patch material. By using larger gangs, having charge of greater mileage, we have in many instances been able to engage men who have a construction experience and in every case men who possess considerable intelligence.

Each year we try to plan so that these men may do some construction work, culverts, small bridges, some water bound or bituminous bound macadam roadways. In this way we maintain their interest and improve their workmanship. The foremen are employed for twelve months in the year and foremen with sections of 25 miles or more have at least one man with them the year round, but they have permission to hire more help when required.

These foremen look after the snow roads in winter, trim trees in early spring, and as many of them have been with us since the commission was formed we feel that they are taking a personal interest in maintaining the road in their division to as high a standard of efficiency as the money available will allow.

Between seasons they paint guard rails, place direction signs, lengthen culverts, cut weeds, etc. They report weekly to the office on their time sheets what and where they have been engaged for the previous week, and in this way we maintain a check not only on their work but also on the costs. The gang foreman has instructions that he must see personally the whole of his sections at least once a week, and as a matter of custom it has been developed that this inspection is made on Friday, thus guaranteeing the best conditions for the heavy week end traffic.

Our roads so intersect that it is possible with but two exceptions to lay out the foreman's section so that his longest drive in any direction from his home is seven miles. The sections being thus compact are usually

inspected more often than once a week.

Earth Road Maintenance.—Earth roads require constant maintenance because in the very nature of things they deteriorate at every season of the year, and rapidly. Commencing with April we first shape them with a blade grader giving them 7 to 9 in. of crown in a width of 16 ft., care beink taken, however, to first throw the sod into or over the ditch. In operating the grader we find the tractor more satisfactory than the horses because of steadiness of operation.

Following the relatively heavy grading in the spring we use the metal road drag drawn by horses. Judgment, of course, must be used as to when the drag should be put upon the road because there is a different time with different soils for proper dragging. We prefer a hitch so that the blade will make an angle of about 45 deg. with the traveled road. This smooths the road, shapes it and is relatively easy on the team. By means of the length of the hitch we regulate the cut of the drag.

The drag does its best work when the soil is moist but not sticky, but if the ruts are deep it is well to use it when the road is slushy. On clay soils using these methods one can quickly develop a hard, impervious surface. Thus dust is prevented, rain water runs at once to the ditches and the road drys quickly. The best guide as to when to drag is experience with the road itself.

Maintenance of Gravel Roads.—Gravel road maintenance requires more care than earth road maintenance because usually the traffic is of greater and the demand is greater for a higher type of road.

Good gravel roads may under heavy traffic in the fall and spring break up, but when shaped by the grader and dragged in late spring may easily give six months of excellent service. In grading our earth roads we cut the sod right to the ditch line so that the water may run off quickly, but in grading the gravel roads we leave a sod berm, which berm catches the sand and gravel from the roadway and holds it where it may be dragged back to the middle of the highway, otherwise this road metal is washed to the ditch and lost. We do however, cut through the sod berm ditches to let off the water. The dragging of gravel roads brings to the surface a percentage of large stone which should be picked off and can be made to do good service in breaks in the road in the spring.

Traffic conditions frequently require that a dust layer be applied to gravel roads, and bituminous spray will prevent dust, but we have found that it also prevents moisture from entering the roads and a good gravel road always contains a high percentage of moisture. Our recent practice is to use calcium chloride as the road does not develop breaks so quickly and to our mind it is not any more expensive than bituminous spraying. If, however, the gravel road is over a subsoil, that will provide sufficient moisture from below the bituminous spray it is the more satisfactory.

The factors that enter into maintenance costs are so many and variable that only very general statements can be of much value and they only as a guide.

When the maintenance of an earth road reaches 10 per cent of the cost of the gravel it would appear to be good business to gravel it, and when the dragging and scraping of a gravel road can be reduced materially by surface treating it would appear to be good business to surface treat. Road maintenance costs should simply be an expenditure invested to secure adequate returns on the construction investment. The returns we get for construction and maintenance investment is not interest but returns in service.

Provincial Highway Systems of Canada

An expenditure of over $81,000,000 is to be made in the next few years on a connected system of highways in Canada. The mileage of roads and the total outlay for these provincial highways were summarized as follows in a paper presented last month at the annual meeting of the Canadian Good Roads Association by George Hogarth, Engineer of Highways of Ontario:

Province	Mileage	Total
Alberta	2,475	$ 3,694,525
B. Columbia	1,977	10,015.050
Manitoba	4,000	6,602,265
N. Brunswick	1,595	2,914,612
Nova Scotia	1,297	12,493,700
Ontario	1,824.7	22,200,000
Pr. Edward I.	850	850,000
Quebec	1,433	17,390,000
Saskatchewan	7,000	5,329,500
Total	22,451.7	$81,489,652

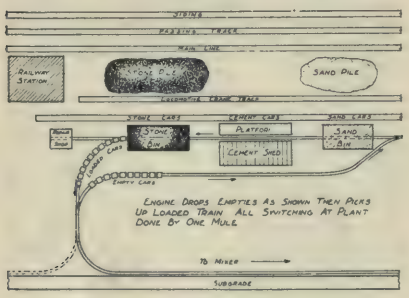
Simple Plant Layout on Concrete Paving Job

Efficient Use of Equipment and Organization on Iowa Road Contract Described in Concrete Highway Magazine

By GEORGE W. ZENOR,
Paving Superintendent, Empire Construction Co., Des Moines, Iowa

Guided by ten years of paving experience, the Empire Construction Co. of Des Moines, Ia., developed its most efficient plant layout and crew organization during the 1922 construction season.

Their contract that season was for 11½ miles of concrete pavement on



Layout of Proportioning Plant.

the North Iowa Pike, extending from Algona, the county seat of Kossuth County, to the east county line. The slab was 18 ft. wide, 8 in. thick and was made of 1:2:3½ concrete. Reinforcement consisted of ½-in square bars spaced 6 ft. apart transversely and three ½-in. bars longitudinally. This is the standard Iowa section.

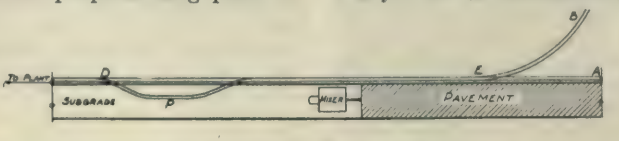
Grades were moderate; the subgrade was composed of soil which stayed muddy for a long time after a rain; and railway sidings were conveniently located. These conditions favored hauling by industrial railway from a central proportioning plant to the mixer and that was the method selected for handling materials.

The proportioning plant was laid out as shown in the accompanying illustrations. The track from the sand bin to the stone bin was given a slope of ½ ft. per 100 ft. which was intended to permit "spotting" by gravity. This slope must be accurately determined, for if it is too steep the cars cannot be stopped, and if too flat they cannot be started. The slope used proved too flat and a mule was required to shift cars at the plant.

Each train was spotted twice—under the sand bin and under the stone bin. Cement was loaded by hand either directly from cars or from the storage shed. With this arrangement a train of eleven cars was loaded in seven minutes. An Ohio locomotive crane with a 50-ft. boom and 1½-yd. bucket handled all aggregates from cars to bins.

A plan of the switching arrangement at the mixer is shown in another illustration. By leaving the loaded cars on the uphill side of the mixer one man was able to push them to the mixer crane, thus relieving the locomotives of any waiting. Three 7-ton Plymouth gasoline locomotives kept the mixer supplied. Fifty Western industrial trucks, 100 Western batch boxes and six miles of 24-in. track with steel ties, completed the hauling equipment. The average haul was 3½ miles.

The mixer was a 21-E Koehring with an attached crane for transferring batches from the cars to the mixer skip. It also had a spreader bucket. The subgrade was trimmed by a subgrade machine, a Lakewood finishing machine consolidated the concrete and a 1-man belting device gave the final finish. Most of the pavement was cured with an earth covering kept wet by sprinkling, but on 1½ miles calcium chloride was used for curing. The calcium chloride came in 100-lb. sacks and one man covered a day's run of concrete with it in half



Arrangement at the Mixer.

Loaded train from plant pulls on passing track "P". Empty train at mixer passes "P" and goes to plant. Loaded train pulls onto E D and waits till cars at mixer are unloaded, then pushes empties onto E B, dropping at mixer 2 or 3 loaded cars which it pulled behind engine, to be used while switching. Shoves loaded cars onto A E, picks up empties on E B, then loaded cars on A E, drops loaded cars on up-grade side of mixer and goes to plant. Loaded cars are pushed to mixer by one man.

a day. Then two men put on a thin earth covering which was found necessary to hold the moisture on the slab. These men also removed all forms.

The following list shows the number of men employed on the job and their distribution about the various branches. The figures are based on an average for the work period, as are all other figures given on yardage and personnel. A sketch also shows the disposition and arrangement at the mixer which greatly simplified the work at that point.

The average crew was organized by the Empire Company as follows:

Men — About Mixer
- 4 Curing concrete and removing forms.
- 2 Finishers.
- 1 Finishing machine operator
- 4 Sprreading concrete.
- 1 Placing reinforcement.
- 1 Mixer man.
- 1 Mixer fireman.
- 1 Shifting cars.
- 3 Dumping batches into mixer skip.
- 3 Form setters.

Finishing Subgrade
- 10 Laborers.
- 1 Rollerman.

Men — Hauling
- 3 Locomotive drivers.
- 3 Brakemen.
- 5 On track maintenance.

Proportioning Plant
- 3 Dumping cement.
- 2 At aggregate bins.
- 1 Man and one mule switching cars.
- 7 Unloading aggregates (two shifts).

General
- 1 Superintendent.
- 4 Foremen.
- 1 Timekeeper.
- 1 Mechanic.
- 1 Pumpman.
- 1 Water line maintenance.
- 2 Water boys.

The average run per ten-hour day was 1,220 sq. yds.

Pennsylvania Contractors Must Speed Up.—Secretary Wright of the Department of Highways of Pennsylvania has written a letter to all contractors engaged in state highway construction, notifying them that the department's policy hereafter will be rigidly to enforce the clause in contracts relating to the time limit for the work, and penalties will be enforced where construction is unnecessarily delayed.

Trees and Hedges Replace Guard Rails.—The Division of Highways of the Department of Public Works of Massachusetts has adopted the policy of planting quick growing trees and hedges to replace guard rails.

Gravel Road Maintenance With "Spring Scrapers"

Method Employed in Kent County, Michigan, Described in Paper Presented Feb. 14 at 9th Annual Michigan Conference on Highway Engineering

By OTTO S. HESS,
Road Engineer, Kent County.

The system of maintenance which will be outlined in this paper has been developed in Kent county during the past two years, and the ensuing remarks will apply more particularly to Kenty county rather than to the State as a whole.

While this system would undoubtedly operate to good advantage in a great many counties, it is not advocated by the writer as a cure-all for the many difficulties which are encountered in the maintenance of gravel roads.

Highways of Kent County.—At the present time, Kent county has 252 miles of improved gravel roads on the county road system. Of this mileage, 90 miles lie on the state trunk lines, and the remaining 162 miles are county roads. In the early maintenance season of 1920, all of this mileage was taken care of by teams hauling light graders or floats. About this time, the county tried out a maintenance machine which was new at that time but which is quite well known throughout the state and even outside the state at the present time. This machine is the spring scraper which is used as a truck attachment and operates as a blade scraper underneath the middle of any truck.

The first "spring scraper" was so successful that the team patrols were gradually replaced by the so-called truck patrols, until at the beginning of the maintenance season of 1922, all of the teams had been replaced and the entire mileage of 252 miles of gravel roads was being kept smooth by nine trucks with scraper attachments, making an average of 28 miles per truck.

Work of Truck Patrols.—Under the present system, Kent county is divided into four maintenance districts. The trucks are operated from a central point in each of these districts. A very thin layer of finely screened gravel is kept on the surface of the road at all times. By scraping this surface often enough it has been found

impossible to maintain a surface which is smother to ride on than most pavements. The number of times per week or per day which is necessary to scrape the surface in order to keep it in this condition is dependent on the whether and the volume of traffic, but more particularly on the volume of traffic. The amount of scraping, and, consequently, the cost of maintenance has been found to be very nearly in direct proportion to the volume of traffic using the road.

The type of trucks which has been found to be most economical in Kent county are those in the 2 to 3 ton class. These trucks carry a 10 ft. blade, which is placed under the truck in a diagonal position, and travel at a speed of 8 to 12 miles per hour. The blades are 10 in. wide to start with, but are worn down with about two weeks steady use to a width of 3 or 4 in.

Each truck on scraping work is able to travel from 60 to 90 miles per day. Each truck scrapes a path approximately 9 ft. wide. With reference to the quality of work done, it can truthfully be said that the old team patrol system was never able to keep the roads as smooth as they have been maintained by trucks. In fact, the gravel roads of Kent county have never been in as good condition as they were in 1922, when they were maintained entirely by trucks.

Saving Effected by Substituting Trucks for Teams.—Some idea of the saving which can be effected by substituting trucks for teams can be obtained by comparing the daily costs of each. In actual practice is was found that one truck would, on the average, replace six team patrols. In 1922, teams with drivers cost $6 per day, making $36 per day for six team patrols. One truck could be hired, with driver, at $20 per day. This shows a direct daily saving on the pay roll of $16 per day per truck. Assume that the number of days worked during the season was 200 and we have:

200 days × $16 × 9 trucks=$28,000 which is the direct pay roll saving during 1922. As a matter of fact and record, the actual saving was about $30,000 for the reason that Kent county operated its own trucks at about $15 per day instead of hiring them at $20. As a further saving which is effected by the scrapers, it should be remembered that it is necessary to buy and maintain only one scraper as compared with six outfits of teams. Another advantage, which is by no means unimportant, is the fact that the trucks can haul gravel or other materials and scrape the roads at the same time. This is a feature which saves many thousands of dollars in a year's time, and is not obtained by any other type of road maintenance equipment in use today.

Table I—Maintenance Cost of Gravel Roads on State Trunk Line System in Kent County

Sec.	No.	Mileage	Total Cost	Cost per per Mile	Average Daily Traffic	Number Vehicle Miles	Cost per Vehicle Mile
13	1	7.50	$ 9,139.59	$1,218.60	1,791	2,686,500	$.00340
13	3	7.00	10,634.76	1,519.25	1,810	2,534,000	.00419
13	4	5.00	8,235.54	1,647.11	2,025	2,025,000	.00460
13	5	14.50	12,077.29	832.11	838	2,430,200	.00496
37	8	2.00	1,414.41	707.20	594	237,600	.00595
37	10	5.50	3,819.89	694.53	594	653,400	.00584
16	14	14.00	17,358.33	1,239.88	1,305	3,654,000	.00475
39	16	11.50	5,836.71	507.54	594	1,366,200	.00427
39	18	1.50	446.22	397.48	680	204,000	.00218
44	20	13.50	12,380.47	910.77	1,079	2,913,300	.00425
66	15	2.50	958.55	383.42		No Traffic Count	
54	23	14.50	9,610.89	662.82		No Traffic Count	
Totals, Averages		99.00	$91,912.64	$928.31		18,704,200	.00435

Cost of Maintenance.—In order that one may obtain some idea of what this maintenance work costs, Table I has been prepared, showing the cost per mile, volume of traffic, and cost per vehicle mile for all of the gravel roads on the state trunk line system in Kent county:

In explanation of the table, the writer would advise that the total number of vehicle miles for any section was obtained by multiplying the average daily traffic (as determined by a traffic census taken in July and August) by 200, and then by the number of miles in the section, assuming that 200 times the average daily traffic in the summer would represent the total traffic for the year. This shows that the average cost per vehicle mile on the state trunk line gravel roads was a little less than a half cent.

It should be borne in mind that the above costs include nearly $15,000 worth of dust layer (Calcium Chloride

applied), which, if deducted from the total cost, would reduce the cost per vehicle mile to one-third of a cent.

The above table covers the cost of all work of every description which was carried out on the roads listed. Let us carry this a little further and analyze the cost of maintaining the surface of the road only. An examination of the records and accounts of Kent county shows that the total cost of gravel, dragging and patching, and equipment rental on the machinery used for 1922 on the roads listed above was $52,552. By dividing this amount by the total number of vehicle miles we get a cost per vehicle mile of $0.0028 or just slightly over ¼ ct.

It is the belief of the writer that truck-scraper maintenance machines are quite largely responsible for the above costs, which appear to be extremely reasonable, especially in view of the fact that all of the roads were kept in excellent condition practically all of the time.

Motor Driven Power Lift Scarifier

A scarifier attachment for the Avery 10-ton road roller, designed for operation by the power of the motor, has been brought out by the Avery

Avery Scarifier Attachment.

Co., Peoria, Ill. The teeth of the scarifier are raised or driven into the ground by the motor power direct and controlled by one lever. A suitable reducing mechanism driven by a clutch on the motor crank shaft drives a crank shaft mounted under the subframe of the machine through a timing clutch. This crank shaft drives a rock shaft at the rear end of the machine through spring loaded pitman rods, which raise or lower the teeth. These springs act as shock absorbers to the mechanism. Teeth are driven into the ground by a toggle mechanism under great pressure. The tooth bar is 4 in. square steel turned down at ends for 20 in. gauge wheels. The teeth are carried in holders clamped to square bar, are adjustable as to side spacing, depth and angularity to ground. Seven teeth of 1¾ in. square tool steel, 32 in. long and pointed on both ends are furnished. All pull strains are taken on the draw bar. When teeth enter ground 9 in., they will clear 11 in. when lifted. The distance over gauge wheels is 83 in.

Colonel Sawyer Appointed Secretary of the Associated General Contractors

Colonel D. H. Sawyer has been appointed secretary of the Associated General Contractors of America to fill the place of Mr. Eugene Young who recently resigned to enter business in Minneapolis. Born in Mt. Pulaski, Ill., Col. Sawyer graduated in engineering from the University of Illinois. Going East after graduation, he was engaged in engineering and building operations for about a year when he returned to his native state, becoming City Engineer of Paris, Ill. Later, as chief engineer of the Illinois Traction system, he had charge of the construction of most of the interurban lines of that company which connect the larger towns of Central and Southern Illinois. In 1908 Col. Sawyer joined his brothers in the Northwest, forming the firm of Sawyer Brothers, who, with offices in Seattle and Spokane, engaged in consulting and designing engineering owrk, covering fields of municipal improvement, irrigation, drainage and kindred work. Summoned to Washington late in May, 1917, he was soon commissioned a major in the Quartermaster Corps and assigned as Construction Quartermaster to build the original Camp Grant. Upon the completion of this assignment and during the remainder of the War, Col. Sawyer was engaged in building a nitrate plant near Cincinnati, Camp Bragg, and in a supervisory capacity was in charge of construction of quartermaster storage projects throughout the East and Central West. Following his resignation from the military service, he became associated with the James Stewart Company being engaged on various building enterprises. Col. Sawyer brings to his new position years of experience in the engineering and construction fields which peculiarly fits him for the secretaryship of the Associated General Contractors with its large opportunities for furthering the interests of the general contractors of the country.

Education of Highway Engineers

Demand in Canada and Specialized Studies Discussed in Paper Presented June 12, at Annual Convention of Canadian Good Roads Association

By R. de L. FRENCH,
Professor of Highway Engineering, McGill University, Montreal, Que.

The year 1900 might be said to mark the birth of highway engineering, as we think of it now. Pretty much all that we know, or think that we know, and I can assure you that there is a great deal which we do not know as yet. There is probably no branch of the engineering profession so closely related to as many others, so dependent upon economic studies for success, nor so beset by rule-of-thumb methods as highway engineering. The economics of highway engineering is almost a science in itself, but one with which the road builder must be passing familiar, or he is sure to come to grief. Rule-of-thumb methods are the curse of any profession and are like the disease of childhood, unavoidable and giving way to more scientific ones as the profession attains years of dignity and understanding.

The Demand for Road Builders.—The training of road builders has become a matter meriting the most serious consideration. Increasing traffic demands, new types of traffic and mounting costs have combined to make it necessary that the utmost care shall be exercised to secure a dollar's value for every dollar expended. In the United States, the Highway Education Board has been organized for the purpose of fostering the right type of training. It has estimated, roughly, of course, that at least 1,000 trained men per year are required there to take care of highway construction and administration as these should be taken care of.

In Canada, we have no need of such a large number, but there is a very real and pressing demand for trained men, nevertheless. I should say that about 100 men could be advantageously absorbed every year by the Federal and Provincial highway authorities, contractors and other interested organizations. In addition, there are many now employed in highway work who would be the better for some supplementary education.

Classes of Men to be Considered.—To my mind, there are three classes of men who must be considered in discussing any program of highway education. They are:

1. The foreman, call him what you like, whose knowledge must be largely practical, but who would benefit by a better understanding of the fundamentals underlying his work.

2. The engineer not in highway work, who is, however, pretty sure to come into contact with it in some form sooner or later.

3. The comparatively small class of those who feel a "call" to devote their professional lives to road building.

The training of foremen and other similar subordinates can be and is being quite successfully carried out by means of short courses, sometimes supplemented by laboratory work, and always planned to stimulate the interest of the student to the maximum and bring out as much discussion as possible. Such courses are offered by some of our universities, and have also been conducted by the highway authorities themselves. The results have been so satisfactory that I think we may consider this particular problem settled, except that provision for such training is needed in areas now without it.

Nearly all our universities and colleges giving engineering instruction provide for some undergraduate work in high way engineering and allied subjects. While there is little doubt but that the work along these lines will improve, I consider that, on the whole, it is fairly satisfactory, and meets the needs of the general student well. Thus we may justly feel that we have taken care of the interests of the second class of man, or are in a way to do so in the not very distant future.

Methods of Training.—Opinions differ as to the best methods of training along specialized lines. Educators are divided into two camps—those who feel that it can be accomplished in the under-graduate years, and those who think that such training should be reserved for graduate work. I confess that I incline to the latter belief.

A rather careful analysis of the courses in civil engineering given at seven of the leading Canadian universities shows that the division of time between "fundamental" and "special" studies during the four years to be about as follows, on the average:

Year of course	Hours in year	Fundamental subjects Hours	%	Special subjects Hours	%
1	875	745	85	130	15
2	875	745	85	130	15
3	875	675	80	200	20
4	875	635	75	240	25
All	3,500	2,800	80	700	20

For a thorough-going course in highway engineering we have, therefore, apparently about 700 hours available, or the equivalent of a little less than the average academic year. I say "apparently," as in reality I do not believe that there is this much time which may be used.

Specialization in 3rd and 4th Years.—No specialization of value can be attempted in the first two years of an undergraduate course, for the reason that at this time the student has not yet acquired enough "fundamental" education to profit by special teaching. Thus, we should deduct 260 hrs. from our 700, leaving 440 hours in the third and fourth years. Included in the latter figure is the time used for instruction in special subjects which should form part of a real highway engineering course.

An examination of the calendars of the universities referred to will show that approximately 50 per cent of this time is so occupied, leaving only 50 per cent for other purposes. We are cut down, then, to 220 hours in which we must impart a sound knowledge of road design, location, construction, maintenance, finance, economics and administration. This is the equivalent, say, of six lectures of one hour and four drafting room or laboratory periods of three hours each per week for the common 12-week term.

There may be those who would undertake to give a comprehensive training in this limited time, but I am not among them. There are also, to my mind, other objections to much specialization for undergraduates. As a rule the student is immature, and, I am sorry to say, many are not enough in earnest to profit greatly thereby. There is generally little opportunity for the correlation of classroom and laboratory work with the conditions of actual practice. Much time may be devoted to extra-curriculum activities, which is as it should be, and of which I, for one, am heartily in favor, since I believe that often much of the value in a collegiate training is obtained through contact with one's fellows and participation in student affairs.

Advantages of Graduate Work.—Most of the objections urged against undergraduate specialization do not apply at all, or at most apply with very much diminished force, to graduate work. More stringent admission regulations may be enforced, with the result that the unfit and the lazy may be barred out. Since numbers should be, and are, small, it is not necessary to adhere to a definite schedule, hence the "punishment fits the crime," and each man can get instruction adapted to his mental peculiarities, so far as it is possible for his teachers to provide it.

The pull of student activities is much lessened when one's former close associates are no longer at hand. Since the class is now replaced by the individual, its restrictions disappear, and with them the feeling, wrong but common, that getting an education is a battle, and the instructor and the class the combatants. In short, a graduate student must stand on his own feet, must show a genuine interest in his work, cannot shirk, and offers far less of a problem to his teachers than the undergraduate.

You may agree with me that the advantages of graduate courses are manifold and obvious: then your question will naturally be, "How can we provide the facilities for such work, and how can we induce men to utilize them once they are provided?" This is where the rub comes. After four years of expense in a university, the average man cannot be expected to face the prospect of an additional year or two of the same sort of struggle with pleasure. Often, the inclination to continue study is present, but funds to make continuation possible are absent.

Providing the Funds.—I believe that the provision of an adequate number of properly trained highway "experts" can be assured only by the provision of opportunity for graduate work. Suitable courses should be established in, say, four of our universities, strategically located from the geographical standpoint. The cost of operation should be met by those most interested in getting the proper type of men into highway work—the provinces primarily, with perhaps some assistance from the Federal Govern-

ment, producers of road-building materials, contractors and others. I believe that admission to such a course should be restricted, if possible, to men with a year or two of practical experience. To attract such men, the value of the scholarships should range from $500 to $750 per year, exclusive of tuition fees, etc.

Here, it seems to me, is an opportunity for somebody. To those of you who are in the business of spending public money for highways, I need not mention the advantages of having a body of trained men to choose from. To those of you who are trying to make some money for yourselves or your stockholders out of the "road game," I would add the lure of possible research in helping to solve some of your problems.

Our universities are, I think, reasonably well-staffed for such work, and the larger ones are well equipped. What we all lack is funds. If you gentlemen really believe that there is a need for trained men, you will have to see that the money to educate them is provided from some source. In comparison to the amount of money being spent on roads in this Dominion and the amount which is sure to be spent within the next few years, the sums required for proper education are trifling, and the results obtained should many times outweigh them in value.

Relative Mileage of Federal-Aid Roads

The following figures given by the Bureau of Public Roads of the United States Department of Agriculture, apply only to Federal-aid roads. They represent 25,000 miles of road now in use and include roads built in every State. The 25,000 miles is divided by types as follows:

	Per cent
Gravel	39.1
Graded and drained	20.6
Cement concrete	18.3
Sand clay	10.8
Bituminous macadam	4.0
Bituminous concrete	3.1
Water-bound macadam	2.7
Brick	1.4

Complete figures covering all roads constructed and now in use would undoubtedly show somewhat higher percentages of the lower types of road, since the more important roads have been selected for improvement with Federal aid.

Pavement Construction Without Sub-base Treatment

Practice at Worcester, Mass., Described in Paper Presented Feb. 21 Before Boston Society of Civil Engineers

By J. C. BLAKE,
Street Commissioner, Worcester, Mass.

We hear a great deal of engineering talk about foundations and subgrade preparation for pavements, but in my city there is but one piece of pavement which has ever been given sub-base construction treatment.

Our city has the usual New England sub-soil conditions, our valleys many of them showing gravel deposits and our hills being of hardpan. This hardpan of course is a very difficult subsoil in the spring months and also during the summer rains.

Use of Road Oil on Hill Side Surfaces.—One of our greatest life savers has been the application of light road oils to hillside surfaces which previous to this application we would usually find in the valley below after heavy thunder showers but which, subsequent to its application, would usually shed any quick rain thereby saving us many thousands of dollars of street maintenance each year. It is, however, more desirable to retain these surfaces in a more permanent manner and consequently the idea was introduced of a 4-in. cobble stone penetration of either tar or asphalt. This pavement was applied direct to the hardpan surface. We have many miles of it in Worcester. It is the only thing that we have ever found which would cheaply and successfully tack down the hillside street and not allow it to run away into the valley in the springtime and under heavy downpours continuing for a long period.

The stone we use brings smiles to the faces of engineers who look over our crushed stone piles. This stone is manufactured in the winter time, providing a great amount of winter labor, stacked in piles and handled by steam shovel into carts or auto trucks in the spring. The crusher jaws are open, much wider than is usual, in this manner allowing the damp gravel to go through without choking, and the product is usually what would be considered a 3-in. stone, many of the cobbles passing through as large as the size of my fist. I believe that the entire success of penetration work de-

pends on a large size stone being used as the first course, allowing a penetration which goes clear to the bottom of the stones and makes on final completion a solid pavement from top to bottom. That there has been no necessity for any sub-grade preparation is indicated by many of these streets which are today 6 to 12 years old and are still showing no signs of final disintegration and no deterioration of riding quality.

Pavement Construction Without Subgrade Preparation.—No cement concrete pavement constructed in the city of Worcester has ever had any preparation of sub-grade other than the natural sub-soil of the street on which it was placed. Many of these are on hardpan. Some are at least 15 years old. Only one of these pavements has been replaced up to the present time, that being one of the first, constructed at a time when little was known of the penetration method of cement concrete construction, and, due to excessive roller action, which is now omitted in such construction, more than to action of frost or traffic, this street got into such shape that it was spiked up, rolled and covered with an asphalt concrete top. The others are in existence today, and giving excellent service.

Last year the city constructed a section of 8-in. reinforced-concrete pavement on one of its heaviest-travelled streets—this was laid on natural soil over a section of muck swamp on which a sewer once settled and broke apart. Naturally I realized that this is against all precedent of construction on the Massachusetts state highway work, but I have been given to understand that in New York state highway work construction less than 10 per cent of their state highways are constructed on anything other than the natural sub-soil occurring in the section where the road is to be constructed.

In the one case as above indicated we have used a plastic style of pavement on the natural sub-soil, in the other case we have used a rigid type of pavement on the natural sub-soil, and I cannot see that in either case over a long period of years through which these highways have been constructed that the frost action has been of any material damage to the pavement. Naturally if it would affect a rigid pavement like cement concrete it would also affect a rigid pavement like granite block.

Cement Grouted Granite Block Pavement.—The city of Worcester possesses the best cement-grouted granite-block pavement in the United States. This statement I will not qualify and it is recognized by engineers throughout the country. No single piece of this pavement has ever received any sub-grade treatment and it is all deposited on the natural subsoil whether it be a grouted granite-block pavement on a concrete base or on sand cushion on a natural sub-soil. It may be that you are going to question this last statement, due to the fact that some of our pavements are deep granite blocks cement grouted laid on a sand cushion without a cement concrete base, but the cushion used was simply for the purpose of bedding the blocks for ramming and not as a provision for sub-grade construction.

New Type of Monolithic Granite Block Pavement.—I have in mind a new style of pavement which I wish to try out in connection with these deep blocks which will be a novelty in construction which I do not think has ever before been attempted. The process will be as follows:

On a sub-soil properly graded will be placed the thickness desired of cement concrete mixed in the following proportions: One part cement, 2 parts sand, 3½ parts of ½ in. to inch crushed stone or clean screened pebbles. These will be mixed moist or damp. On this the granite blocks will be bedded and immediately rammed. Following this the granite blocks will be wet down previous to the application of a 1 to 1 cement grout. The application of the water and the application of the wet grout will sufficiently moisten the concrete base course as it is a well known fact that in general practice concrete is mixed too wet and that an application of as little as 15 per cent too much water will decrease the strength of the concrete from 30 to 50 per cent. The grouting shall immediately follow the ramming and will complete a monolithic pavement making it one unit from top to bottom which I am confident will stand heavier traffic, if the old style 6 to 7-in. block is used, than any modern type of granite block pavement constructed today, as it will form a monolithic arch across this street which no present day traffic will break down; there will be no joint which would not bond as there is in granite-block-paved streets where the

base is constructed and allowed to set, followed by either cement mortar or sand cushion and grouted, where there is a line of cleavage and the pavement is not monolithic.

We have also our own asphalt plant and have constructed many successful asphaltic concrete tops for worn out macadam streets and also tops for cement concrete base. I may state also that all of these pavements constructed on concrete base have been constructed on a natural sub-soil and are giving excellent service.

Portable Gyratory Crushing Plant

A complete portable gyratory crushing plant for producing finely crushed product for road building and other purposes is illustrated. The crusher is mounted on a strong I beam frame with heavy wheels having tires of ample width. The back gear drive is substantial, and so arranged that the power unit is located at right angles with the plant where it is out of the way of teams or cars bringing the stone or gravel from the pit or quarry. Numerous combinations of crusher,

Austin Portable Gyratory Crusher With Gravel Feeding Conveyor, Grizzly Screen and Elevator.

elevator, screen and conveyor, each adapting itself to some particular local conditions are available. The illustration shows the outfit for handling gravel. It consists of a crusher, portable gravel feeding conveyor, grizzly screen, and folding elevator. The conveyor is made in lengths from 30 to 50 ft. and has a belt 18 in. in width. The lower end of the conveyor is set in a shallow excavation and a trap built over the hopper. The gravel can then be brought directly to the trap by wagons, wheelers, drags or fresnos. The belt conveyor provides a uniform continuous feed to the crusher, thereby greatly increasing its capacity. The conveyor is raised and lowered by means of a crank and worm wheel raising device. It is easily portable by attaching its lower end to the rear of a truck or wagon. The outfits described above are made by the Austin Manufacturing Co., Chicago, Ill.

Illuminated Flash Signals for Pennsylvania Grade Crossings

Representatives of numerous railroad corporations in Pennsylvania within ten days will confer with William H. Connell, Deputy Secretary of Highways, relative to the co-operation of railroads and the Pennsylvania Department of Highways in the erection of illuminated flash-signals at grade crossings. A few years ago the Public Service Commission suggested that the Department of Highways co-operate with the railroads of Pennsylvania in the erection of advance warning signs at grade crossings. Signs erected as result of that cooperation have been of great value, but because of increased traffic on primary highways it is the thought of the Department that additional safety measures should be taken as soon as possible at important grade crossings. The Department of Highways has been investigating various flashing devices which work continuously day and night. Two of the signals will be necessary at each grade crossing. Deputy Secretary Connell in a recent letter to the heads of all railroad corporations suggested that before July 10 these companies advise whether or not they will co-operate to the extent of paying 50 per cent of the initial cost of the flash-signals, with the understanding that maintenance after erection will be by the Department. A number of railroad heads have notified Mr. Connell that they will be in Harrisburg within the next few days for a conference. The proposed signal automatically flashes a red light day and night, and gives warning of the proximity of a dangerous crossing at a grade.

Improved Road Mileage and Automobiles in Pennsylvania.—From 1911 to 1922 the mileage of improved road on the Pennsylvania State Highway system increased 502 per cent. From 1911 to 1922 the number of motor vehicles in Pennsylvania increased 1917 per cent.

Truck Operating Costs

Part II

An Analysis of the Factors Entering Into Trucking Costs, With Explanations of Errors Which Have Lead to Many Unsuccessful Ventures in This Field

From Bulletin No. 10 of the Engineering Experiment Station of Purdue University, February, 1923

By BEN H. PETTY,
Assistant Professor of Highway Engineering

[Part I of this bulletin containing general discussions and explanations together with condensed data was published in the Roads and Streets issue of Engineer and Contracting for June.]

Systems Used in Recording Operating Cost Data.—Many different systems of recording truck cost data are in use by different operators. Some are satisfactory but may of them are inadequate, leaving out different essential items of cost.

One of the best and most complete systems is the National Standard Truck Cost System put out by the Truck Owners' Conference of Chicago. This system is the result of careful study of a great many existing cost systems by a number of men interested in truck transportation. This standard system has been thoroughly tested and many thousands have been sold to truck manufacturers and operators since its origin in 1919. The use of a standard system of this type enables owners more readily to compare their truck costs and to derive the benefit of a wider knowledge of trucking costs.

Costs kept on this standard system, or a similar type, and intelligently analyzed, enable the user:

1. To compare one truck against the other as to detailed performance and itemized costs, thus determining which unit size and type of truck is best suited to his particular trucking conditions.
2. To decide which drivers are giving best service by checking them on repair costs, gasoline consumption, etc.
3. To pick out types of trucks that are making the most profit.
4. To rent out trucks at a safe margin of profit.
5. To prove where it is cheaper to ship by truck than by rail.

Daily Service Record.—Fig. 1, (Form 4) shows the daily service record of the National Standard Truck Cost System. This is to be filled out by the driver and turned in daily. It is very important that the type of road be noted. This can be recorded on the back of card with any other special information. Improvement could be made in this form by providing space for the latter information on its face.

Monthly Service Record.—Fig. 2, (Form 1) shows the monthly record on which the data from the daily record is entered each day. It will be noted that this sheet is divided and records both operating data and cost data. If the owner is not interested in analysis of operation, then the data under the heading "Time in Hours and Minutes" can be omitted.

It will be noted that this sheet provides a final column for recording substitute vehicle rental. Some concerns prefer not to charge substitute vehicle expense against a truck. If so charged, it should only include rental necessitated by ordinary repair and overhaul. Where the truck is charged with this expense it should be credited with the work performed by the substitute truck.

Monthly Analysis of Operation.—Fig. 3, (Form 2), provides for a monthly analysis of operation using the totals from the monthly record sheet, Fig. 2. Spaces are provided for twelve months on the one sheet. This analysis of operation is very important. Many an operator has been disagreeably surprised, on making his first analysis of operation, to find his trucks have stood idle or have been laid up for repair for a large percentage of the time. However if only a cost analysis is desired this form sheet can be left out entirely.

Monthly Analysis of Costs.—Fig. 4, (Form 3), provides for a record of investments and fixed charges at the top of the sheet. The bottom half provides for a yearly record of costs as transferred from the totals on the monthly record, Fig. 2.

Analysis of Truck Cost.—Fig. 5, (Form 10), provides for a compact an-

Form 4 NATIONAL STANDARD TRUCK COST SYSTEM.-TRUCK OWNERS CONFERENCE, INC. CHICAGO.

DAILY SERVICE RECORD (TO BE TURNED IN DAILY) TRUCK NO._____

NO. OF TRIPS	TRIP TIME		DELIVERY OR PICKUP STOPS	LOAD UNITS		HELPER USED	TRAILER USED	MONTH	DAY	192
	LEAVE	RETURN		OUT	IN					
1.								ACCEPTED FOR WORK AT		
2.								RELEASED FROM WORK AT		
3.								MILEAGE READING FINISH		
4.								MILEAGE READING START		
5.								MILEAGE TODAY		
6.								GASOLINE OR K. W. H.		
7.								CYLINDER OIL PINTS		
8.								LUNCH TIME START		
9.								LUNCH TIME FINISH		
10.								DRIVER		
	DAILY TOTALS							USE REVERSE FOR REMARKS ON DELAYS. WEATHER, ROAD, ACCIDENTS, MISCEL. EXPENSE, ETC.		

Fig. 1—Daily Service Record Blank.

alysis of costs on one sheet. The data for this analysis can be secured from the preceding forms or it can be gathered from the operators records. It also provides for an accurate analysis of specific runs over individual routes, and under conditions which vary from the usual. It is a very convenient

Form 3 NATIONAL STANDARD TRUCK COST SYSTEM. TRUCK OWNERS CONFERENCE, INC., CHICAGO

MONTHLY ANALYSIS OF OPERATION CAPACITY____ MAKE____ *FISCAL YEAR____ TO____ TRUCK NO.____

*Period First Month of Fiscal Year in Heading of First Column, Etc.													6 Mos Total or Average	12 Mos Total or Average
A. Number of Days Operated														
B. Number of Round Trips														
C. Delivery or Pick-up Stops														
D. Total Units ____ Out														
E. Total Units ____ In														
F. Miles Traveled														
G. Gallons of Gasoline or K. W. H. Current														
H. Pints of Cylinder Oil														
I. Hours Available but Not Used														
J. Hours Loading														
K. Hours Running Including Stops														
L. Hours Laid Up for Repairs														
M. Hours with Helper														
N. Trailer Data														
Averages from Above														
B 1 Round Trips per Day														
C 1 Delivery or Pick-up Stops per Day														
D 1 Total Units ____ per Day														
E 1 Average Units ____ per Trip														
E 2 Unit ____ Miles per Day														
F 1 Miles Traveled per Day														
F 2 Average Round Trip Distance														
G 1 Miles per Gal. of Gasoline or per K. W. H.														
H 1 Miles per Gallon of Cylinder Oil														
J 1 Average Hours Loading per Day														
J 2 Average Minutes Loading per Trip														
K 1 Average Hours Running Including Stops per Day														
K 2 Average Hours in Service per Day														
P. Average Speed in Miles per Hour														
Q. Estimated Running Time per Mile														
R. Estimated Time per Customers Stop (in Min.)														
S. Cost per Day Operated														
T. Cost per Mile														
U. Cost per Unit ____														
V. Cost per Unit Mile														

Fig. 3—Monthly Analysis of Operation Blank.

form for making out estimates on truck costs. This form has been keyed throughout in such a way as to make it self-explanatory. Comprehensive experience in truck cost analysis is not essential to the intelligent application of this form to specific haulage requirements. Complete instructions for using the form are printed on the back of the sheet.

Some actual cost figures have been entered on Fig. 5 covering the operations of a 1½ ton truck over city streets. The total cost per day, item (61), is $12.79 which is reasonable for this size of truck. The average truck operator will hardly believe that a 1½ ton truck could cost 47 cents per mile to operate. When all the cost items are included, as they have been in this

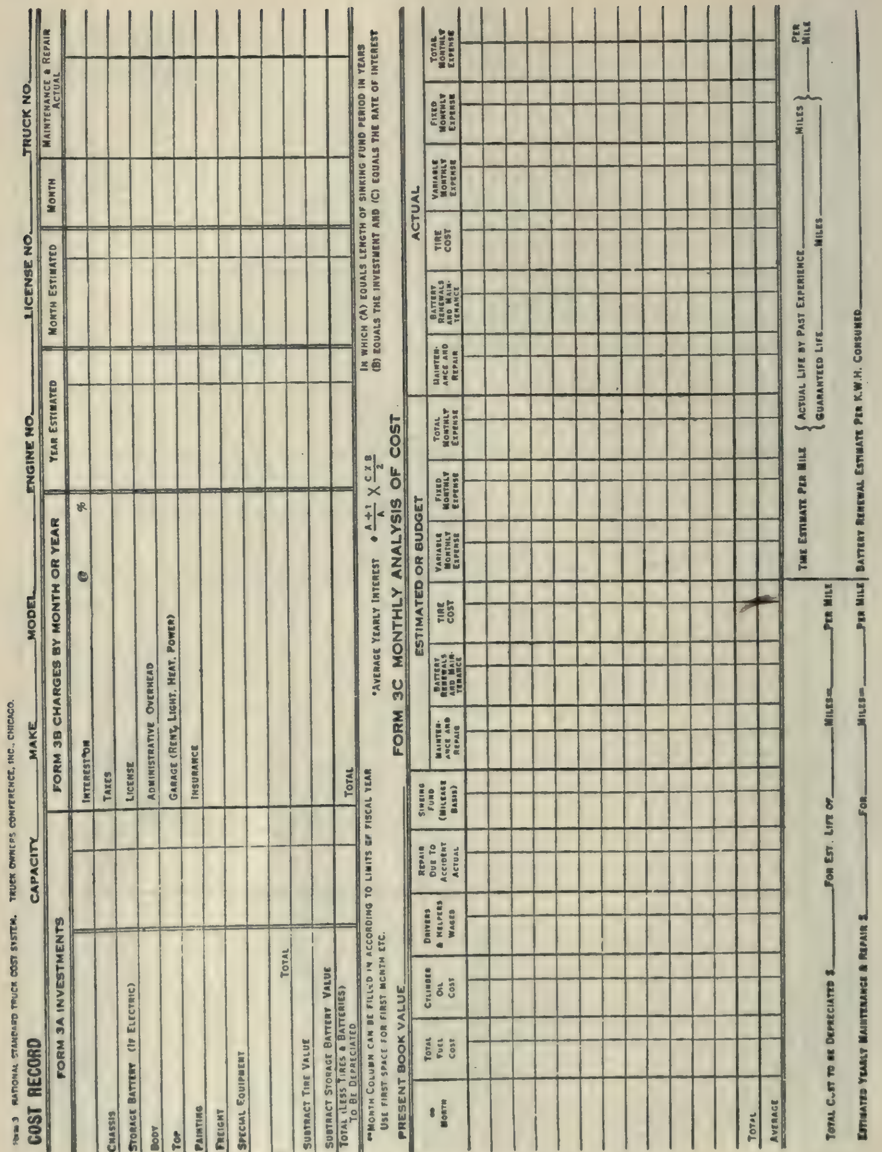


Fig. 4—Cost Record and Monthly Analysis of Cost Blanks.

case, there will be very few operators who can display costs per mile as low as 15 to 20 ct. (figures frequently used on estimates) for a similar truck under similar operating conditions.

Conclusion.—Someone is bound to suffer if motor haulage rates are based on misleading cost data. In the case of the successful operator, who prospers by virtue of excessive rates, the public is the loser. On the other hand the operator, who attempts to haul freight at less than actual cost of operating, must sooner or later go out of business.

Accurate cost data on truck operations will enable operators to fix just prices for hauling commodities and convince the "rate cutter" of the error of his ways. Obviously the

Form 1 NATIONAL STANDARD TRUCK COST SYSTEM TRUCK OWNERS CONFERENCE, INC., CHICAGO Form 3548

DAILY RECORD, MONTH OF _____ ; HOURS IN WORKING DAY _____ FROM _____ TO _____ TRUCK NO. _____

OPERATING DATA																								COST DATA (Posted to Page 3a)											
Shift	Business	Travelling	Purpose of Trips	Employer or Pick-up Stops	Total Units (See 3)		Sales	Time in Hours and Minutes										Gasoline or Current		Cylinder Oil		Repair Cost	Repair Cost	Cost of Repairs											
					Out	In		Actual Hours Not Work		Loading		Unloading Including Stops		Lost or Not Reported		Gals. or K.W.H.	Cost	Pints	Cost			Mechanical Charges	Labor Charges	Labor and Material Shop	Accident Shop and Garage								
								Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.																				
1																																			
2																																			
3																																			
4																																			
29																																			
30																																			
31																																			
Total																																			

Fig. 2—Daily Record Monthly Blank.

Form 10 NATIONAL STANDARD TRUCK COST SYSTEM. TRUCK OWNERS CONFERENCE, INC., 5 S. WABASH AVE., CHICAGO

CHECK SOURCES OF DATA
- ☐ National Standard System
- ☐ Individual System
- ☐ Owner's Records
- ☐ Owner's Estimates
- ☐ Investigator's Estimates

No. 726N22

Date 7-27-21

ANALYSIS OF TRUCK COST

According to National Standard Cost Practice of the Truck Owners Conference
H. P. GOULD, Chairman

Owner John Doe Age of Truck at Start of Period 2 Months

Address 100 Truck Ave. Baltimore, Md. Period Covered 11 Mos. to 6-1-21

Operation Hauling machinery and mill supplies

Truck Capacity 1½ Ton Make A Model 1920 Body _____ Mfrs. No. 76849 Truck No. 1

Analysis of Operation							
	A.	Number of Days Operated 280	C	Delivery or Pick-up Stops 1902	E.	Total Units 4994.25 C.W.T.	
	B.	Number of Round Trips 1195	D	Total Units 8172.39 C.W.T. Out.	F.	Miles Traveled 7566	

3A. Investments.			3B. Fixed Expense			Year Estimated		Mtg. and Repair—Actual as Guide to (35)		
(1) Chassis	$3950	00	(11) *Interest, Item (8) 5 Yrs. @ 7 %	$	185	44		(20) $		
(2) Storage Battery (if Electric)	$		(12) Taxes (Property)	$	88	00		(21) $		
(3) Body	$ 367	00	(13) License (State, City, etc.)	$	15	00		(22) $		
(4) Top	$		(14) Administrative Overhead	$	150	00		(23) $		
(5) Painting	$		(15) Garage (Rent, Light, Heat, Power)	$	216	00		(24) $		
(6) Freight	$ 98	27	(16) Insurance	$	92	00		(25) $		
(7) Special Equipment	$			$				(26) $		
	$			$				(27) $		
(8) Total	$4415	27	(17) Total Fixed Expense per Year	$	746	44		(28) $		
(9) Subtract Tire Value	$ 439	90	(17a) Total Prorated for Period	$	684	23		(29) $		
(9) Subtract Storage Battery Value	$		(18) Total Fixed Expense per Month (17 ÷ 12) (17a ÷ A)	$	62	20		(30) $		
(10) Total (Less Tires and Batteries) to be Depreciated	$3975	37	(19) Total Fixed Expense per Day	$	2	44		(31) $		
Present Book Value	$		*Interest Formula $\left[\frac{A+1}{4} \times \frac{C \times B}{E}\right]$ In which (A) equals length of nothing fixed period in years, (B) equals the investment, (C) equals the rate of interest. Allow an item on depreciation reserve.					(32) Total For Period $ 20	00	
								(32a) $ .0026		per Mile

Depreciation Total Cost (10) $ 3975.37 For Minimum Life of (33) 4.000 Miles = (34) $ .0994 Per Mile

Maintenance and Repair: Estimated for Period (35) $ 320.83 For (F) 7566 Miles = (36) $ .0424 Per Mile

Repair Due to Accident: (Not Covered by Insurance) (37) $ _____ For (F) _____ Miles = (38) $ _____ Per Mile

Tire Cost: (9) $ 439.90 For Life of (39) 10000 Miles { By Actual Experience / Estimated (Cancel One) } = (40) $ .0440 Per Mile

Fuel Cost: (41) 1162 Gals. (42) @ 32 ¢ per Gal. = (43) $ 371.84 For (F) 7566 Miles = (44) $ .0491 Per Mile

Cylinder Oil Cost: (45) 40 % Gals. (46) @ 60 ¢ per Gal. = (47) $ 24.52 For (F) 7566 Miles = (48) $ .0032 Per Mile

Battery Renewals and Maintenance: (49) $ _____ For (F) _____ Miles = (50) $ _____ Per Mile

Total Variable Expense: For Period (51) $ 1801.46 (Excluding Driver's Wages) Per (F) 7566 Miles = (52) $ .2381 Per Mile

Total Fixed Expense: For Period (17a) $ 684.23 Per (F) 7566 Miles = (53) $ .0904 Per Mile

Total Driver's Wages: For Period (54) $ 1096.00 (@ (55) $ 3.91 per Day) Per (F) 7566 Miles = (56) $ .1449 Per Mile

Total Cost: For Period (57) $ 3581.69 For (F) 7566 Miles = (58) $ .4734 Per Mile

Cost per Day, Variable Expense: (52) $ .2381 per Mile × Average Miles per Day (59) 27 = (60) $ 6.4287 Per Day

Fixed Expense: _____ = (19) $ 2.4437 Per Day

Driver's Wages: _____ = (55) $ 3.9143 Per Day

Total Cost per Day: _____ = (61) $ 12.7867 Per Day

[NOTE—To figure the cost on other mileage per day, multiply the average for the period (item 59) or average mileage per day (item 18) by the number of miles desired, and add items (19) and (55) which remain the same. Operating conditions should be the same, otherwise item (19) will vary.]

Cost per Unit: Total Cost for Period (57) $ 3581.69 ÷ Total Units Hauled (D+E) 13166.64 (62) $ .2720 per (Unit) C.W.T. (Unit) C.W.T. Miles for Period (63) 416.88.66 = ½ Total Miles $\left(\frac{F}{2}\right)$ × Average Load per Trip $\left(\frac{D+E}{B}\right)$ or $\left(\frac{F}{2} \times \frac{D+E}{B}\right)$.

Cost per Unit-Mile: Cost per Unit (62) $ .2720 ÷ ½ Round Trip Distance or $\left(\frac{1}{2} \times \frac{F}{B}\right)$ = (64) $ .0859 Per (Unit) C.W.T. Mile

Fixed Rates Per Day by the Fixed Mileage Conference (Mode)					
Bus	8.00				
Bus	1.00				
Light Car	2.00				
Light Car	1.00				
Truck Car	10.00				

Capacity	(57) Cost for Period	(4) Days Operated	(61) Cost per Day	(59) Miles per Day	(F) Miles Traveled	(64) Cost per Mile	(62) Cost per C.W.T.	(63) Cost per C.W.T. Mile	(63) Miles per C.W.T.	(63) Miles per Day
1½ T	$3581.69	280	$12.79	27	7566	$.4734	$.2720	$.0859	6.5	185

Fig. 5—Special Analysis of Truck Cost Blank Containing Actual Record of Operating Costs.

keeping of complete and accurate cost records by those engaged in truck transportation will go a long way toward putting the business on a sound economic basis.

Motor Truck Production.—Fig. 6 (not reproduced herewith) shows the variations in annual production of

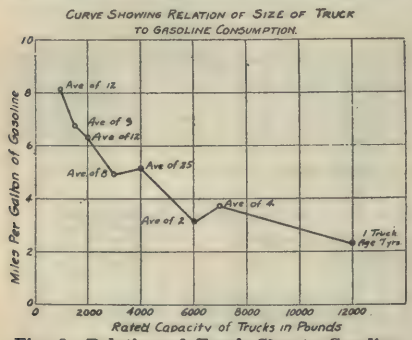


Fig. 8—Relation of Truck Size to Gasoline Consumption.

motor trucks in the United States. The curve rises rapidly during the war period reaching the peak in 1920. The following year witnessed a drop of practically 50 per cent and the 1922 production totaled 242,975. This drop is a reflection of business conditions since 1920.

Fig. 7 (not reproduced herewith) shows the production of trucks by capacities during 1921 and illustrates very clearly the great demand for the smaller sized trucks. More one-ton trucks were manufactured than all

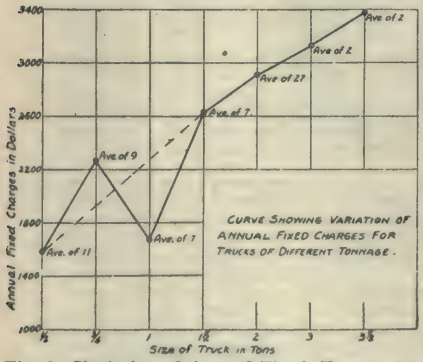


Fig. 9—Variation of Annual Fixed Charges for Trucks of Different Tonnage.

other sizes combined. The ¾ ton or less ranks next. The 5 ton size exceeds both the 2½ and 3½ ton size, probably due to its increased use in hauling such commodities as coal, gravel, sand, cement, etc.

Fig. 8 illustrates the increased consumption of gasoline with capacity of truck. This is evidently not a straight line increase, but a curved line concave upward. It would require the

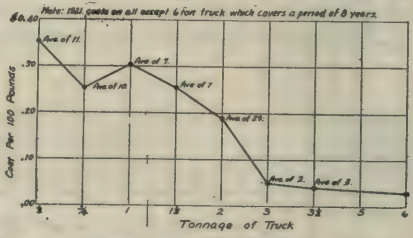


Fig. 10—Actual Hauling Costs per Cwt. for Trucks of Different Sizes.

average of many more trucks than are indicated on this figure to fix the limits of such a curve.

Fig. 9 shows the variation of annual fixed charges with variation in truck tonnage. Up to the 3½ ton size this is apparently quite close to a straight line variation. In this figure the deviation of the ¾ ton and 1 ton sizes is probably due to some special case consideration and should not be taken as typical. Above the 3½ ton

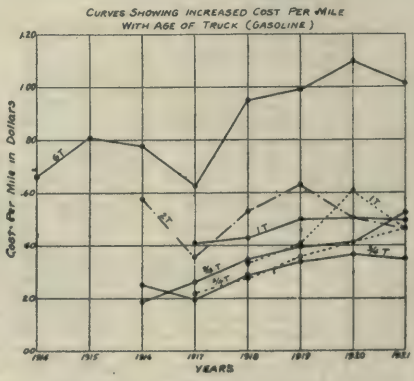


Fig. 12—Curves Showing Increased Cost per Mile with Age of Truck (Gasoline).

size the line will flatten out as the increase in fixed costs are not directly proportional to capacity above that point. For instance the cost of a 5 ton truck is only slightly greater than the cost of a 3½ ton truck.

Fig. 10 shows the decrease in hauling costs per cwt. for an increase in truck capacity. Obviously the cost for cwt. hauled on a six ton truck loaded to capacity would be less than on a ¾ ton truck at capacity load.

Not enough trucks are averaged in this figure to fix a definite variation.

Fig. 11 (not reproduced herewith) shows increase in gasoline consumption with age of truck. While there is some fluctuation on individual curves, the general tendency is towards a much greater consumption of gasoline per mile as the truck grows older in service. This is to be expected. In some cases this increased consumption amounts to practically 50 per cent.

Fig. 12 shows the increase in operating cost per mile with age of trucks. Here again there is fluctuation in the various curves but the general cost tendency is upward. The period covered is from 1916 to 1921 except in the case of the 6 ton truck which covers the period from 1914 to 1921. Necessarily these costs are influenced by the high price period from 1918 to 1921.

Fig. 13. (not reproduced herewith) is similar to figure 12, but covers operating costs of electric instead of gasoline trucks. The rapid rise in the right half of these curves is a result of the high prices prevailing after the war period.

Method of Calculating Cost for Operation of Trucks.—Keep two accounts on your books for each machine:

First, the truck account, to which

Truck No. 1—2, ¾ Ton, B.

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1916a	3,549	655,732	882.81	[illegible]	$ 0.1350
1917b	13,143	1,542,920	2,583.34	.1966	.1674
1918	10,691	994,108	3,059.71	.2863	.3075
1919	10,464	708,486	3,544.32	[illegible]	.5003
1920	9,912	873,159	3,623.85	.3658	.4153
1921	8,232	1,063,540	2,871.65	.3488	.2700

Truck No. 1—3, ¾ Ton, B.

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1916c	5,092	395,447	943.82	.1851	.2385
1917	11,118	1,067,201	2,889.93	.2600	.2734
1918	8,737	1,229,002	2,997.01	.3430	.2438
1919	8,105	834,357	3,165.21	.3905	.3793
1920	8,523	1,210,814	3,515.69	.4128	.2904
1921	4,660	699,825	2,444.86	.5246	.3493

Truck No. 1—6, ¾ Ton, B

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1917c	8,546	784,602	1,862.19	.2179	.2373
1918	10,538	1,455,954	2,915.08	.2795	.2022
1919	9,679	933,401	3,439.91	.35 4	.3570
1920	9,232	1,127,356	3,795.09	.4111	.3366
1921	5,932	987,428	2,734.25	.4069	.2769

Truck No. 1—13, ¾-Ton, B.

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1919d	6,931	895,429	2,571.93	.3711	.2872
1920	8,933	923,122	3,524.93	.3937	.3820
1921	8,888	1,677,687	3,223.50	[illegible]	.1924

Truck No. 1—7, 1 Ton, E.

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1917e	4,860	1,559,084	1,953.86	.4041	.1260
1918b	7,270	2,291,876	3,116.05	.4286	.1360
1919	7,134	1,567,681	3,562.68	.4993	.2272
1920	6,962	1,450,098	3,489.33	.5012	.2406
1921	6,202	1,396,105	3,056.96	.4928	.2205

a. 4 Months.
b. Year ending Oct. 31st.
c. 8 Months.
d. 9 Months.
e. 7 Months.

Variations in Operating Costs with Age of Gasoline Trucks.
Truck No. 1—2 3 2 Ton B.

Truck No. 1—11, 1 Ton, E.

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1918a	2,387	820,854	793.78	$0.3325	$0.0967
1919	8,336	3,057,438	3,400.10	.4079	.1112
1920	5,429	1,080,599	3,268.74	.6020	.3025
1921	6,600	1,862,171	3,085.83	.4612	.1657

Truck No. 1—10, 1½ Ton, E.

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1918f	8,054	2,493,297	2,535.40	.3148	.1017
1919	8,294	2,778,170	3,788.20	.4567	.1364
1920	8,243	1,884,506	3,868.01	.4692	.2051
1921	7,359	1,399,988	3,568.30	.4849	.2548

Truck No. 1—4, 2 Ton, G.

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1916g	1,271	1,147,546	725.09	.5709	[illegible]
1917	7,639	4,424,787	2,649.49	.3527	[illegible]
1918	5,648	3,508,205	2,990.01	.5294	.0852
1919	5,684	3,624,493	3,569.33	.6280	.0985
1920	8,284	2,993,586	4,153.86	.5014	.1387
1921	5,926	4,067,422	2,759.96	.4657	.0678

Truck No. 1—14, 2 Ton, B.

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1919h	2,573	1,318,224	1,590.75	.6182	.1207
1920	10,201	3,558,282	3,492.70	.3423	.1010
1921	7,6 4	1,797,679	3,395.15	.4441	[illegible]

Truck No. 1—15, 2 Ton, B.

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1919h	2,849	1,320,150	1,616.66	.5674	.1225
1920	11,041	3,555,027	3,536.44	.3203	.0995
1921	8,437	2,869,551	3,578.68	.4241	.1247

Truck No. 1—1, 6 Ton, E.

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1914a	[illegible]	5,906,298	1,245.12	.6591	$0.0210
1915	4,786	18,919,159	3,859.39	.8064	.0204
1916	5,682	18,756,699	4,403.90	.7750	[illegible]
1917	4,871	12,395,789	3,054.86	.6271	.0246
1918	3,425	8,818,236	3,251.02	.9456	.0365
1919	3,234	10,409,850	3,198.32	.9890	[illegible]
1920	2,515	8,414,472	2,763.64	1.0989	.0328
1921	2,456	7,247,880	2,493.11	1.0151	[illegible]

a. 4 Months.
f. 10 Months.
g. 3 Months.
h. 5 Months.

Variation in Operating Costs with Age of Gasoline Trucks.
Truck No. 1—11, 1 Ton, E.

No. 1—81, 2 Ton, (Y) Electric

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1915	7,381	1,769,100	$2,904.17	$0.3934	$0.1641
1916	6,467	2,019,100	2,895.88	.4478	.1434
1917	5,475	1,980,127	2,609.53	.4784	.1317
1918	6,896	1,704,200	2,993.57	.4341	.1756
1919	5,551	1,507,094	3,456.07	.6226	.2293
1920	4,644	1,731,280	4,235.84	.9121	.2448
1921	4,804	1,779,350	4,336.95	.9073	.2447

No. 1—82, 2 Ton, (Y) Electric

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1915	7,274	1,717,800	2,912.81	.4004	.1696
1916	7,189	1,818,900	2,612.11	.3659	.1436
1917	6,092	2,317,720	2,858.16	.4691	.1233
1918	6,938	1,702,400	3,172.74	.4553	.1864
1919	5,305	1,425,700	3,904.57	.7482	.2721
1920	3,865	1,703,630	4,333.76	1.1213	.2556
1921	4,876	2,342,370	3,865.13	.7927	.1650

No. 1—83, 2 Ton, (Z) Electric

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1915	7,215	1,623,450	3,041.42	.4215	.1873
1916	7,528	1,774,400	2,474.43	.3287	.1394
1917	7,008	1,796,710	2,657.27	.3791	.1479
1918	5,210	1,181,700	2,094.47	.4020	.1772
1919	4,908	1,275,580	3,659.31	.7455	.2868
1920	3,433	1,397,275	3,298.09	.9601	.2360

No. 1—86, 2 Ton, (Z) Electric

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1915	4,697	5,133,036	2,308.78	.4915	.0450
1916	5,928	5,081,514	2,317.73	.3910	.0456
1917	4,856	3,615,314	2,483.89	.5115	.0689
1918	4,241	3,255,250	2,993.07	.7057	.0919
1919	4,457	3,722,160	3,052.20	.6848	.0824
1920	3,515	3,387,800	3,997.86	1.1374	.1180
1921	3,214	2,988,920	3,464.65	1.0780	.1159

No. 1—84, 3½ Ton, (Z) Electric

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1915	4,229	10,252,431	2,686.21	.6359	.0262
1916	4,334	9,640,087	2,553.23	.5891	.0265
1917	5,138	8,003,155	2,398.07	.4667	.0300
1918	4,922	7,940,085	2,833.92	.5677	.0357
1919	5,424	9,345,376	3,221.82	.5930	.0344
1920	5,563	7,525,404	3,608.64	.6487	.0480
1921	3,195	5,077,314	3,689.55	1.1579	.0729

No. 1—85, 3½ Ton, (Z) Electric.

Year	Total Mileage	Total Pounds	Total Expense	Cost per Mile	Cost per 100 lbs.
1915	4,128	10,943,053	2,706.39	.6556	.0247
1916	4,415	9,032,722	2,379.83	.5390	.0263
1917	4,279	7,396,400	2,403.81	.5617	.0327
1918	5,026	7,723,143	2,881.28	.5732	.0373
1919	4,964	8,220,345	3,028.02	.6100	.0368
1920	5,041	6,875,886	3,627.21	.7195	.0527
1921	2,865	6,449,520	3,733.69	1.3032	.0579

Variation in Operating Costs with Age of Electric Trucks.
No. 1—81, 2 Ton (Y) Electric.

Purdue Number	Purchased New	Make	Size	Kind of Tires	1921 Period Covered	Total Mileage	Total Gals. Gasoline	Miles per Gal. Gasoline	Total Cost	Cost per Mile
2-8.....	?	D	½ T	Pneumatic	5 Mos.	4,147	471	8.8	$1,034.30	$0.25
2-7.....	Sept. 1918	I	1 T	Pneumatic	12 Mos.	4,447	856	5.2	2,406.49	0.538
2-11.....	Mar. 1916	I	1 T	Pneumatic	8 Mos.	3,324	487	6.8	1,293.99	0.390
2-13.....	Mar. 1920	I	1 T	Pneumatic	12 Mos.	5,395	876	6.2	2,563.24	0.476
2-16.....	July 1918	I	1 T	Pneumatic	12 Mos.	5,609	962	5.8	3,025.12	0.540
2-17.....	Aug. 1920	I	1 T	Pneumatic	2 Mos.	1,074	155	6.9	384.26	0.358
				Averages for 1 Ton Truck...			....	6.2		0.460
2-12.....	April 1918	I	1½ T	Solid	12 Mos.	1,804	550	3.3	2,322.79	1.29
2-14.....	July 1920	I	2½ T	Cushion	12 Mos.	3,359	742	4.5	3,162.76	0.944
2-15.....	July 1919	I	2½ T	Pneumatic	11 Mos.	7,823	1,064	7.4	3,291.36	0.420
				Averages for 2½ Ton Truck.			....	5.9		0.682
2-10.....	July 1919	I	3½ T	Solid	12 Mos.	1,329	412	3.2	3,095.39	2.33

Operating Costs of Gasoline Trucks in Baking Industry.

Purdue Number	Purchased New	Make	Size	Kind of Tires	1921 Period Covered	Total Mileage	Total Pounds Hauled	Total Cost	Cost per 100 lbs.	Cost per Mile
2-1....	May 1917	X-Electric	¾ T	Solid	12 Mos.	3,906	242,983	$2,447.50	$1.01	$0.627
2-2....	May 1917	X-Electric	¾ T	Solid	12 Mos.	4,654	345,800	2,726.66	.79	.585
2-3....	May 1917	X-Electric	¾ T	Solid	12 Mos.	4,651	241,506	2,357.94	.98	.506
2-4....	May 1917	X-Electric	¾ T	Solid	12 Mos.	4,036	183,736	2,171.69	1.18	.538
2-5....	May 1917	X-Electric	¾ T	Solid	3 Mos.	931	51,545	509.45	.99	.547
2-6....	May 1917	X-Electric	¾ T	Solid	8 Mos.	597	.....	497.00	....	.833
				Averages omitting the last truck.....					.99	.561

The high cost per mile on Truck No. 2-6 is due to the low total mileage

Operating Costs of Electric Trucks in Baking Industry.

debit the original cost of the truck and any equipment in the form of permanent improvement that may be purchased and any new tires that are purchased at any time, also the annual cost of Insurance, Licenses, Taxes, etc., and cost of any extensive repairs or repainting which amounts to more than $75.00. Credit to this account each month the charges for depreciation on chassis, tires, insurance, overhauls, etc. The balance of this account at any time shows the value of the machine.

Second, the maintenance account, to which charge the monthly items for depreciation and all expenses such as renewal of parts, gasoline, oil, electric current and other operating expenses, with the exception of general overhaul as specified above. Each month charge off the debit balance of this account to

Comparison of Trucks in Packing Industry, Classified by Capacity and Make, Year Ending Oct. 31, 1921. 1½ Ton.

Purdue No.	Make of Truck	Value of Trucks Nov. 1st, '20.	Mileage	Load in Pounds	Deprec. on Chassis, Body, etc.	Insurance, Taxes and License	Deprec. on Tires	Sundry Repairs	Supplies	Interest	Wages and Garage Expenses	Total Expenses	Average Monthly Cost	Cost per Mile	Cost per 100 Lbs.	Value of Trucks Nov. 1 1921	Gallons Gasoline Consumed	Miles per Gallon	Av. Monthly Repairs including Overhauling	Age of Truck
⅓ Ton Trucks																				
1-5	A	$203 25	5,993	345,546	$ 53 62	$171 05	$ 99 42	$113 61	$288 09	$9 67	$1,126.73	$1,862 19	$155 18	$0.3107	$0 5389	$289 85	645	9 29	$16 46	5 Yrs. 3 Mos.
1-9	A	321 78	801	33,140	193 04	160 86	15 14	60 66	30 92	13 16	439 08	912 86	76 07	1 1396	2 7545	228 39	86	9 26	5 05	4 Yrs. 4 Mos.
1-31	A	839 12	3,817	412 725	294 87	151 16	108 96	168 86	165 25	32 76	397 59	1,319 45	109 95	3456	3196	490 63	438	8 71	14 07	2 Yrs. 6 Mos.
1-33	A	766 46	6,028	513,739	445 27	144 12	152 05	182 08	285 64	35 80	869 50	2,114 56	176 21	3508	4116	516 70	831	7 25	37 28	2 Yrs. 2 Mos.
1-34	A.	755 95	5,884	1,086,037	492 58	116 42	132 01	141 86	199 52	34 07	911 12	2,027 58	168 97	3445	1068	490 75	637	9 25	33 08	2 Yrs. 9 Mos.
1-38	A	662 74	7,088	712,958	523 17	143 25	90 14	118 60	194 56	35 90	1,090 34	2,195 06	182 92	.3097	.3079	444 07	563	12 59	35 28	2 Yrs. 8 Mos.
1-40	A	296 05	6,148	334,065	145 08	107 89	233 92	103 82	284 49	9 32	960 81	1,845 33	153 78	.3001	.5458	29 54	882	6.97	8 65	4 Yrs. 2 Mos.
1-42	A	201 60	6,657	342,906	145 08	111 02	190 51	96 23	286 23	8 49	1,035 94	1,883 50	156 96	2829	5497	31 12	949	7 01	5 02	4 Yrs. 4 Mos.
1-58	A	1,143.62	6,074	777,875	630 87	214 43	239 40	377 50	272 78	58 58	947 67	2,741 32	228 44	4513	.3524	1,007 62	830	7 31	81 17	2 Yrs. 2 Mos.
1-66	A	682 00	4,338	1,131,250	856 79	126 08	366 74	295 59	277 96	26 09	1,055 00	3,004 25	250 36	6925	.2655	153 50	925	4 69	57 82	4 Yrs.
1-76	A	404 13	3,051	320,250	351 20	94 58	46 35	257 14	156 66	10 91	513 00	1,429 84	119 51	4686	4464	38 37	489	6 24	21 43	4 Yrs. 4 Mos.
Total Yearly Average per Truck			5,080	545,101	$375 59	$140 08	$152 24	$174 17	$217 46	$24 90	$855 16	$1,939 60	$161 63	$0 3118	$0 3558		661	7 68	28 94	3 Yrs. 6 Mos.
¾ Ton Trucks																				
1-2	B	607 74	8,232	1,033,540	329 94	186 75	177 69	346 97	403 81	24 76	1,401 78	2,871 65	239 30	3448	2700	477 16	1,392	5 91	35 08	5 Yrs. 4 Mos.
1-3	B	294 94	4,660	609,825	574 03	181 94	121 36	187 23	253 34	27 49	1,099 31	2,444 86	203 73	5246	3493	602 27	902	5 16	82 39	5 Yrs. 4 Mos.
1-6	B	635 67	5,932	987,428	413 65	194 50	400 64	142 34	310 00	27 92	1,245 21	2,734 25	227 86	4609	.2769	707 02	998	5 94	40 38	4 Yrs. 9 Mos.
1-13	B	1,483.92	8,888	1,677,687	474 66	178 63	398 90	235 65	354 59	70 18	1,515 89	3,228 50	269 04	3632	.1924	1,246 40	1,117	7 96	34 72	2 Yrs. 10 Mos.
1-26	B	2,071 57	.	911,681	522 72	171 75	568 85	150 43	478 63	96 29	1,057 25	3,045 92	253 83	..	3340	1,563 01	1,491	....	12 54	1 Yr. 8 Mos.
1-27	B	2,216 19	.	917,543	541 08	171 75	308 28	167 20	473 02	100 09	1,047 35	2,808 77	234 06	.	.3061	1,702 85	.	.	13 93	1 Yr. 6 Mos.
1-32	B	1,984 76	8,424	2,416,510	648 94	191 38	291 72	105 73	362 19	83 21	1,109 35	2,892 54	237 71	3386	1180	1,332 16	1,172	7 19	.16 62	2 Yrs. 2 Mos.
1-37	B	1,837 32	7,430	1,600,944	686 35	172 78	283 23	119 51	251 69	83 27	1,270 68	2,847 51	237 29	3832	1778	1,299 81	785	9 46	24 01	2 Yrs. 2 Mos.
1-12	C	1,142 76	3,459	756,012	360 97	186 64	216 19	65 40	203 14	46 57	1,086 08	2,164 99	180 42	6529	2864	821 84	620	5 58	14 66	3 Yrs. 1 Mo.
Total Yearly Average per Truck			6,718	1,203,474	$503 60	$181 80	$307 43	$168 95	$343 38	$ 62 20	$1,210 32	$2,777 67	$231 48	$0 4150	$0 2312		1,060	6 33	$30 48	3 Yrs. 3 Mos.
1 Ton Trucks																				
1-45	D	634 89	3,398	162,187	649 70	73 80	83 73	48 78	157 75	21 88	492 05	1,527 69	152.77	.4495	9414	Sold Sept.	422	8 05	41 15	....
1-46	D	502 83	11,141	975 740	513 95	88 80	217 28	150 44	524 79	24 46	1,234 11	2,753 84	229 49	.3470	2925	260 44	1,353	8 23	37 11	2 Yrs.
1-57	D	1,016,81	4,542	876,140	816 67	193 32	207 88	364 76	302 47	43 62	806 30	2,735 02	227 92	.6021	3122	500 18	899	5 05	62 17	2 Yrs. 3 Mos.
1-77	D	108 16	6,374	373,400	100 72	86 05	63 24	194 36	221 36	3 28	182 00	851 01	70 92	1335	2279	36 76	625	10 20	16 20	3 Yrs. 3 Mos.
1-21	D	1,852	101,017	219 53	88 29	18 59	12 96	42 38	33 35	335 78	750 88	62 57	4032	7216	811 74	167	11 15	14 29	1 Yr 3 Mos.
1-7	E	365 27	8,202	1,386,101	517 01	205 99	58 58	147 88	560 05	9 63	1,557 82	3,056 96	254 75	4928	2205	301 21	2,027	3 06	20 24	4 Yrs. 8 Mos
1-11	E	861 55	5,690	1,862,171	629 87	213 34	158 76	95 31	468 14	24 40	1,496 01	3,085 83	257 15	4612	1657	240 95	1,812	3 69	22 07	4 Yrs. 2 Mos.
Total Yearly Average per Truck			5,879	832,244	$503 83	$138 27	$118 35	$148 73	$331 43	$23 77	$887 03	$2,151 20	$179 27	$0 3656	$0 2585		1,044	5 63	$30 46	2 Yrs. 11 Mos
1½ Ton Trucks																				
1-10	E	1,293.48	7,359	1,399,988	1,040 13	226 96	105 05	88 34	543 35	64 12	1,500 35	3,568 30	297 36	4849	.2548	786 89	1,928	3 28	40 68	3 Yrs. 10 Mos.
1-38	E	864 39	10,299	870,114	579 84	169 64	25 40	187 15	459 33	38 55	1,461 52	2,881 43	240 12	2797	3311	187 89	1,650	5 64	13 10	4 Yrs. 2 Mos.
1-43	E	1,245 03	7,726	526,030	1,175 71	172 16	14 65	25 03	547 82	62 04	1,032 52	2,829 93	235 83	3662	5380	1,347 18	1,066	7 11	108 44	4 Yrs.
1-60	E	1,488 62	6,354	1,081,458	1,275 52	95 00	201 09	126 82	465 38	60 25	1,475 08	3,699 14	308 26	5821	2495	976 55	1,454	4 37		3 Yrs 10 Mos.
1-73	F	639 15	7,478	2,074,800	960 33	121 53	120 58	74 40	485 09	30 95	1,577 00	3,369 88	280 82	4506	1624	170 52	1,513	4 94	48 68	4 Yrs. 4 os
1-74	F	697,81	6,018	1,911,200	939 26	121 53	132 80	256 77	430 94	32 58	1,257 00	3,170 88	264 24	5268	1659	236 20	1,380	4 36	65 78	4 Yrs 4 Mos
1-75	F	659 98	7,338	1,330,400	748.88	121 53	139 12	180 23	438 87	30 08	1,323 00	2,981 71	248 48	4063	2241	513 64	1,413	5 19	63 10	4 Yrs. 4 Mos
Total Yearly Average per Truck			7,510	1,313,427	$959 95	$146 91	$105 53	$129 82	$452 97	$44 08	$1,375 21	$3 214 47	$267 87	$0 4278	$0 2445		1,489	5 05	$50 60	4 Yrs 4 Mos

Comparison of Trucks in Packing Industry, Classified by Capacity and Make, Year Ending Oct. 31, 1921. 2 Ton.

Purdue No.	Make of Truck	Value of Trucks Nov. 1st, '20	Mileage	Load in Pounds	Deprec. on Chassis, Body, etc.	Insurance, Taxes and License	Deprec. on Tires	Sundry Repairs	Supplies	Interest	Wages and Garage Expenses	Total Expenses	Average Monthly Cost	Cost per Mile	Cost per 100 Lbs.	Value of Trucks Nov. 1 1921	Gallons Gasoline Consumed	Miles per Gallon	Av. Monthly Repairs including Overhauling	Age of Truck
2 Ton Trucks																				
1-4	G	489 34	5,926	4,067,422	330.08	238.17	21.75	68.01	352.70	9.05	1,710.20	2,759.96	229.99	.4657	.0678	124.49	1,280	4.63	8.17	5 Yrs. 3 Mos.
1-28	G	904 22	5,069	3,945,480	644.21	225.49	149.10	207.02	339.24	27.11	1,539.50	3,131.67	260.97	.6178	.0764	150.28	1,071	4.73	17.25	4 Yrs. 7 Mos.
1-29	G	2,223 89	5,539	3,726,750	958.58	263.75	136.92	72 20	380.58	91.41	1,369.94	3,273.38	272.78	.5909	.0878	1,354.99	1,307	4.23	6.02	3 Yrs. 4 Mos.
1-30	G	2,870 03	5,672	4,312,077	984.36	290.40	10.50	143.97	434.72	122.98	1,348.04	3,324 04	277.91	.5760	.0773	1,917.41	1,471	3.85	11.00	2 Yrs. 9 Mos.
1-53	G	1,028.28	4,907	1,625,850	1,625.87	241.51	84.61	420.64	541.45	42.71	1,219.17	4,175.96	347.99	.8518	.2568	649.72	1,577	3.11	144.17	4 Yrs. 9 Mos.
1-71	G	3,045 08	5,009	2,020,000	1,386.49	207.71	38.24	75.89	441.84	136.60	1,347.05	3,633.82	302.81	.7254	.1799	2,031.23	1,365	3.70	36.24	2 Yrs. 7 Mos.
1-54	E	3,045 99	7,382	2,094,800	1,599 22	275.82	133.33	387.54	658.97	120.00	1,581.69	4,756.57	396.38	.6444	.2271	1,581.41	2,214	3.33	55.07	3 Yrs. 7 Mos.
1-55	E	3,433 99	5,575	2,032,800	1,550.26	271.33	208.25	332.85	543.27	150.12	1,417.34	4,473.42	372.79	.7770	.2210	2,152.27	1,810	3.16	67.90	3 Yrs. 2 Mos.
1-56	E	3,427.42	7,589	1,830,030	1,361.31	271.29	291.20	383.33	617.24	148.52	1,516.42	4,598.31	382.44	.6047	.2508	2,188.29	2,181	3.48	68.79	2 Yrs. 3 Mos.
1-67	E	3,701.20	5,525	4,885,916	1,199.97	121.82	87.50	108.84	437.56	166.96	1,545.50	3,668.15	305.67	.6639	.0751	2,740.97	1,595	3.47	36.94	1 Yr. 11 Mos.
1-14	B	2,305 36	7,664	1,797,679	679.20	235.36	183.52	112.45	361.21	97.81	1,725.60	3,395.15	282.93	.4441	.1889	1,603.65	1,827	5.94	9.37	2 Yrs. 6 Mos.
1-15	B	2,214 49	8,437	2,869,551	689.35	235.36	424.15	109.15	347.15	103.59	1,669.93	3,578.68	298.22	.4241	.1247	1,753.10	1,220	6.98	9.69	2 Yrs. 6 Mos.
1-16	B	3,289 82	8,327	1,455,928	707.75	267.41	293.01	85.03	567.62	144.71	1,726 11	3,791.64	315.97	.4553	.2604	2,440.48	2,000	4.16	7.08	1 Yr. 3 Mos.
1-17	B	3,235 43	8,597	1,796,259	704 43	266.64	250 93	40.49	401.69	142.69	1,732.31	3,539.18	294.93	.4116	.1970	2,448.95	1,399	6.14	3.37	1 Yr. 3 Mos.
1-18	B	3,398 05	8,744	1,672,477	709.07	253.31	308.97	47.50	467.58	148.92	1,743.77	3,679.12	306.59	.4208	.2200	2,500.75	1,671	5.23	3.96	2 Yrs. 3 Mos.
1-19	B	3,458.46	8,081	1,847,191	788.50	250.50	340.00	36.56	435.30	152.94	1,729 64	3,733.53	311.13	.2021	.4620	2,617.07	1,511	5.34	3.05	1 Yr. 3 Mos.
1-20	B	Started Dec.	8,867	1,357,044	650.07	180.99	319.68	145.31	427.61	133.90	1,455.78	3,303.34	300.30	.3725	.2424	3,113.40	1,447	6.13	12.11	11 Months.
1-24	B	3,074 41	.....	1,542,208	763.80	184.96	332.92	59.77	470.04	137.70	1,047.03	2,996.22	249.69	.....	.1942	2,519.28	1,466	....	16.20	1 Yr. 9 Mos.
1-25	B	3,044 60	.....	1,060,693	751.44	184 63	125.76	103.60	369.06	131.97	814.31	2,480.77	206.73	.....	.2339	2,336.83	1,491	....	12.54	1 Yr. 8 Mos.
1-35	B	3,818.88	6,225	3,328,008	760.20	287.88	273.44	51.64	335.42	166.08	1,240.21	3,114.87	259.57	.5004	.0936	2,733.56	1,093	5.69	4.30	1 Yr. 1 Mo.
1-44	B	Started Jan.	7,606	717,206	640.93	110.92	288.50	22.95	278.12	144.72	1,286.25	2,772.39	277.24	.3645	.3866	2,932.08	607	8.39	2.30	10 Mos.
1-47	B	Started Jan.	10,878	1,882,750	804.03	154.23	154.00	.....	434.40	139.47	1,020.46	2,706.69	270.66	.....	.1437	3,257.17	1,210	8.43	.....	10 Mos.
1-48	B	Started Oct.	680	65,700	58.67	14.65	39.95	.....	14.50	.....	92.51	220.58	220.58	.3244	.3357	3,528.39	...	....	.....	1 Mo.
1-59	B	Started Apr.	4,354	1,273,550	453.98	176.55	318.27	40.76	194.89	107.07	824.95	2,116.47	352.74	.4850	.1661	3,124.92	657	6.70	6.79	6 Mos.
1-61	B	3,402 39	7,182	1,554,635	727.52	159.63	260.17	121.05	559.42	134.56	1,697.78	3,660 13	305.01	.5096	.2354	2,497.61	1,969	3.59	19.25	1 Yr. 3 Mos.
1-72	B	3,830 01	7,049	1,937,570	891.12	176.77	216.00	74.39	367.76	166.20	1,295.77	3,188.01	265.67	.4522	.1645	2,666.48	1,146	6.15	6.10	1 Yr. 5 Mos.
1-80	B	2,848.54	9,218	2,157,927	1,077.63	174.76	107.03	147.53	551.34	115.02	1,664.93	3,383.24	319.85	.4164	.1778	1,888.93	1,348	6.84	26.46	2 Yrs. 1 Mo.
1-52	H	1,437 13	5,921	1,652,738	1,781.19	245.32	51.60	263.52	411.82	54.25	1,235.93	4,043.63	336.97	.6830	.2446	378.64	1,166	5.08	79.44	.....
Total Yearly Average per Truck			6.777	2,282,972	$954.02	$227 43	$212.91	$141.65	$447.79	$124.30	$1,476.39	$3,580.55	$298.38	$0.5285	$0.1570		1,441	4.70	$25.10	2 Yrs. 1 Mo.
3 Ton Trucks																				
1-68	B	4,433 13	6,704	8,755,585	1,130.58	179.40	162.15	146.84	539.97	195 13	1,552.75	3,906.82	325.57	.5827	.0446	3,387.55	1,993	3.36	35.25	1 Yr. 9 Mos.
1-69	B	3,653 65	6,055	6,594,588	1,003 70	212.35	216.00	124 73	552.10	212.72	1,387.77	3,709 37	309.11	.6126	.0562	3,772 44	2,122	2.85	10.40	1 Yr. 5 Mos.
Total Yearly Average per Truck			6,380	7,675,087	$1,067.14	$195.87	$189.08	$135.78	$546.04	$203.92	$1,470.26	$3,808.10	$317.34	$0.5970	$0.0497		2,058	3.10	22.83	1 Yr. 7 Mos.
3½ Ton Trucks																				
1-70	B	Started Nov.	6,418	10,348,582	1,147.70	269.75	216.00	191.24	494 95	218.74	1,338 52	3,876.90	323.07	.6041	.0375	4,230.05	1,889	3.40	23.93	1 Yr.
1-22	B	Started Mar.	7,796	10,181,130	684 90	140.00	224.00	38.64	355.57	158.28	1,016.67	2,618.06	327.25	.3358	.0257	4,306.85	1,532	5.09	5.63	8 Mos.
1-65	E	3,262 31	5,410	7,415,066	1,518.14	178.60	222.34	342.00	487 38	153.33	1,487.75	4,389.54	365.80	.8114	.0591	2,523.20	1,729	3.13	80.77	2 Yrs. 7 Mos.
Total Yearly Average per Truck			6,541	9,314,926	$1,116 91	[illegible].12	$220.78	$190.63	$445.97	$176.78	$1,280.98	$3,628.17	$302.35	$0.5550	$0.0389		1,717	3.81	$36.78	1 Yr. 5 Mos.
6 Ton Trucks																				
1-1	E	141 32	2,456	7,247,850	$183 45	$281.96	.....	$33 35	$325 74	$15.97	$1,652.64	$2,493.11	$207.76	$1.0151	$.0344	$1,010.03	1,081	2.27	58.01	7 Yrs. 4 Mos.

the department in whose service the delivery is made. This amount balances the Maintenance Account each month and shows the cost of operation for the month which should be figured out on the basis of miles run and weight hauled. If the truck is in the service of more than one department, figure the proportion in which the total operating cost will be divided, on the basis of the mileage run in the service of each department. For this purpose a record must be kept of the drivers' cards, (individual for each load), which shows the weight hauled, the mileage run and the department chargeable for each load.

All items of expense must be charged to each individual truck as incurred by that truck.

A low cost per 100 lb. shows that the truck is being kept busy and used to capacity and vice versa.

A low cost per mile shows that the truck is economical to operate.

How to Figure Depreciation.—Compute depreciation as follows:
Gasoline Truck:

Truck:—Divide the value of chassis and body less value of tires by 4½. Divide the resultant figure by 12 to give the monthly charge.

Solid Tires:—Divide the value of original tires by 18, the result being the monthly charge. Treat any new tires in the same manner when bought.

Pneumatic Tires:—Divide the value of original tires by 6, the result being the monthly charge. Treat any new tires in the same manner when bought.

Overhaul, Repainting, etc.:—Divide the total amount by 12, which gives the monthly charge.

Credit all the above monthly charges to the Truck Account and debit to the Maintenance Account monthly until the amount of the original purchase is written off, except the cost of the machine, which should not be written down below $5.00.

Interest Charges:—Charge against each truck, so long as it is in the Company's possession, interest at the rate of 5 per cent per annum, beginning with the original cost and every month thereafter on the value at which the machine stood in the books at the first of the month.

(Operator No. 1)

Capacity	Number of Trucks	Average Mileage	Average Tonnage	Deprec. on Chassis, Body, etc.	Insurance Taxes and License	Tires	Sundry Repairs	Supplies	Interest	Drivers' Wages and Garage Expenses	Average Total Expenses	Cost per Mile	Cost per 100 Lbs.	Gallons Gasoline Consumed	Miles per Gallon
¾ Ton	4	6,928	1,107,120	$448.06	$185.46	$274.64	$228.07	$330.44	$37.34	$1,315.53	$2,819.56	$.4069	$.2546	1,102	6.29
1-½ Ton	8	6,750	1,549,421	728.00	215.43	107.46	110.58	533.84	32.73	1,518.09	3,237.09	4796	2089	1,922	3.51
2 Ton....	7	8,867	1,828,018	704.05	241.30	202.89	82.37	420.72	132.06	1,681.88	3,574.38	4031	1955	1,505	5.89

NOTE: The ¾ ton trucks have pneumatic tires.
The 1 and 1-½ ton trucks have Sewell tires.
The 2 ton trucks have pneumatics on front wheels and Sewell tires on rear.

Trucks Making Store Door Deliveries Year Ending Oct. 31, 1921.

Traffic Inspection Officers for Pennsylvania Highways

The Pennsylvania State Highway Department will shortly place traffic officers on the highways. These men are provided for in the section of the Act of 1923 which amends Section 12 of the Act of 1919, governing motor traffic. This amendment authorizes the Secretary of Highways to employ such men as in his discretion are deemed necessary to the enforcement of the penal provisions of the motor laws. "Our traffic officers will pay particular attention to the overloading of trucks; speed of motor vehicles—and particularly the speed of trucks; the misuse of headlamps. No truck will be permitted to use Pennsylvania highways when it carries a load greater than that specified for the particular class in which it is registered. No truck will be permitted to travel faster than the rate specified for the class in which it is registered. The traffic inspection force is to be uniformed. The force will be mounted upon motor cycles. Certain members engaged in enforcing the law relating to truck weights will use motor cars in which their road scales will be carried. The number of men in the new force has not been decided. The law did not fix a limit, saying merely that the Secretary of Highways may employ such men "as in his discretion are necessary."

Equitable Distribution of Cost of Construction, Interest on Bonds, Replacements and Maintenance of State Highways

Paper Presented at the Joint Sessions of the North Central Division of the National Highway Traffic Association and the Michigan State Good Roads Association

BY ROY D. CHAPIN,

Vice President, National Automobile Chamber of Commerce, and President Hudson Motor Car Co.

We can be assured that the premises upon which we are laying the foundation for vast highway systems are intrinsically sound. This need is not a temporary one and we are justified in large expenditures, so long as we can be assured that the policies which we lay down for the control of those expenditures are wisely shaped.

The task which confronts us, then, is one that requires the wisdom of the statesmen, the vision of the social economist, the acumen of the financier and the efficiency of the engineer.

At the outset it places a heavy burden upon all responsible authorities, with a sure compensation ahead for those who proceed with the needs of all in mind, and with just as sure a reaction against those who give heed to special as opposed to the general welfare.

Manufacturing Problem Presented.—In any analysis which I have made of the subject of highway finance, I have been impressed with the fact that what we are concerning ourselves with is fundamentally a business proposal. After all we are not dealing merely with the building of roads. We are dealing instead with the production of transportation, which is just as much of a manufacturing process as is the building of the motor vehicle itself.

Accordingly, the business analogy presents itself as a sound rule for highway policies, since in its adoption we return to principles which have been tested and found practical over a long period of years.

The first item then is to analyze the need. This we have done. Next we must determine just what roads are essential to earn the income which shall justify our expenditure, how rapidly these roads shall be built, which ones shall take precedence.

Analysis of Financial Resources.—Knowing these factors which can only be surely determined by careful and accurate surveys, not alone of traffic but of economic possibilities, we must then proceed to analyze our financial resources, determine our possible income and then proceed to select that type of administration which will build our highways most carefully and most economically, with due regard for the purposes for which they are intended.

Policies Will Vary.—The first question, then, which confronts us is a determination of the present stage of development of this manufacturing plant which we are taking over. If it is a going concern, with ample facilities in the shape of already improved highways, then we will probably find that we can draw sufficient revenue to meet our requirements from current operating income. We may need a short term bond issue here or there to take care of a special extension such as a widened road or improvement from an inferior to a superior type of pavement, but in the main we can pay-as-you-go.

Of all of the states in the Union, Maryland is perhaps the best example of this kind which we have and one of the very few, since Maryland has already improved most of its main system through long term bonds and is now concerned chiefly with the maintenance of these highways to meet the traffic requirements.

If we are discussing a state such as Michigan, however, we will find a somewhat different situation. A $50,000,000 state bond issue, coupled with county and federal funds, will complete all of the state system except the 400 miles added by the last legislature. That completion, however, does not include improvements of a number of gravel roads which must be raised to a higher type because of increased business or traffic, and consequntly, the situation may present the need for new manufacturing facilities or roads which may require a

supplementary bond issue, the extent of which will depend upon the actual growth of traffic in the interim.

Virginia Example of New Territory.—Then we turn to a state such as Virginia, only now upon the threshold of a venture in the production of transportation. Here the plant is in such shape that if we hope to care for the business which is awaiting us now, we must immediately turn to a bond issue as the means of raising the initial capital outlay, as otherwise the drain on our current income would be so great that while we might be able to construct our roads, we could not maintain them. And it is just as absurd to build roads and not maintain them as it would be to build a factory and allow it to go to pieces.

Beyond that, however, we have accepted theories in business finance which apply definitely to the case at hand. No large business organization today, or few small ones, will attempt to finance capital expenditure out of current income. The reasons are obvious. If for example, a manufacturer should say, "I need a new factory. It will cost me $50,000 and will produce 10,000 tires." He could not then say, "I will distribute that cost $5 per tire over my next year's output." Business competition would not permit such practice, but he could distribute that cost over a period equivalent to the length of life of the factory, and then assess each consumer accordingly.

What Is Life of Highway?—The question which then arises is, "What is the life of this factory?" You will hear men say that our roads are going to pieces and that the analogy between business and engineering practice breaks down at this point.

If this question arose in a business plant, the executive would call in his research men and put the question to them. Suppose we call upon the research men of the U. S. Bureau of Public Roads, or, taking a short cut, turn directly to the report of the chief of the bureau, T. H. MacDonald.

"Much that we have known about highways is not so," we read, and summarizing an official viewpoint we find that a close survey made by the Bureau shows that 40 per cent of all of the Federal Aid projects costs has gone into permanent features of the highway, such as location, drainage, gradients, curvatures, shoulders and engineering costs. Of the remaining 60 per cent allotted to surface costs, we find that when the time for reconstruction of the highway comes all but a percentage equivalent to the cost of interest and sinking fund is salvaged as bedding for the new surface.

In a word, we find that we have been led into the fallacious belief that to lose the surface has been to lose all.

Lack of Maintenance Funds Costly.—But this is not all. The executive searching for still further supporting data finds that in many cases the actual reason for surface deterioration has been a lack of adequate maintenance, an overloading of equipment in times of seasonal strain. Expert opinion tells him that the engineer can build the road to handle the traffic and that all that is required is absolute maintenance.

The judgment then is that we are justified in distributing our capital costs, provided we require maintenance, and we can proceed knowing that what we are doing is to provide as expeditiously as possible a network of highways which we shall have the use of in our life-time and which we shall pass on to our children for their use in turn, each generation paying a fair rental charge in the form of maintenance costs plus amortization costs.

Will it cost us more to follow this plan than to pay the charge from current operating expense? Yes. Are we justified? Yes. How? By these two facts, either of which is sufficient. First, we are supplying a universal human need—adequate transportation for all. Second, the increased use of the highways by the public in our own lifetime will more than offset the amortization charges, even if we could deny the increased valuations which will accrue to urban and rural properties, which we cannot. Moreover, if we built from current funds, we should have an average of only 50 per cent of the use of a given mileage in, say, a 10-year program, while by paying as we use we shall have practically a 100 per cent usage. Yet the difference in cost is only found in the amortization charge.

Rigorous Limitations Necessary.—We shall not make these statements, however, without imposing certain rigorous limitations. One, that of maintenance funds, has been mentioned and it cannot be stressed too emphatically.

Further, state bond issues should not be sought for roads of purely local

use. Generally speaking, these will carry only a light traffic and maintenance costs will suffice. State issues should be concentrated on those highways which traffic and economic surveys show are of first importance from the state point of view. If this system is carefully laid out, it will be found that there are few points more than 15 miles from a main road and the policy of financing these feeders will depend upon the character and extent of the traffic.

Again, the administration is an important element. The leaders must be men of vision who will deal with this problem as with any major issue of public welfare. Control should be centralized in their hands, as the local man cannot be expected to, nor should he, consider state needs first. Any departure from such a program as this is likely to result in disconnected highways and the question of maintenance becomes a highly uncertain equation.

Traffic Regulation Paramount Issue.—The question of traffic regulation is another where only the state official can act with due regard for the economic needs of the community. We have indicated that overloading of the plant has been a partial cause for its breakdown in the past. Power should be lodged with the state authority so that he can prohibit overloading the vehicle in normal times and can make such restrictions as to loads as will safeguard the general welfare at seasonal periods.

By the same act the commissioner should have power to permit overloading in emergency. The only purpose for road construction is to serve traffic and situations such as the present railroad congestion may make it cheaper at times to break down an inadequate highway surface than to permit unemployment, hunger or cold to come to a community.

This brings us logically to a discussion of what kinds of highways we shall construct. The answer is found solely in economics. That type of highway should be constructed which will care not only for the present but for the future needs of traffic. No highway improvement is justified if it does not satisfy a human need or unless the cost of improvement is more than cared for in the saving effected to the public through better and cheaper service. The problem is so large, the needs so many and diversified, that over-development is just as serious an economic error as underdevelopment.

Construction and Maintenance Defined.—How are we going to pay for this improvement? In a general way we have said that original construction is a matter of capital outlay; so also is any extension or any replacement of an inferior by a superior type of pavement to the extent of the difference in cost. The analogy is that of a new factory building or the replacement of old machinery by improved units.

Maintenance then becomes all of the remaining charges or in effect the constant making of needed repairs up to and including reconstruction, in order that the plant may give service at all times.

At this point we are faced squarely by the need for saying from what sources we are to draw our income in order that our finances shall be equitably levied so that the public may buy its transportation at the lowest possible cost.

Answer Varies with Locality.—The answer will vary in detail according to the stage of development of the system or plant with which we are dealing. It will vary according to population, square miles in area, mileage of roads under consideration. But still we have before us definite principles based upon studies of fact which well may be taken as sign posts.

It is a safe principle to say that those who benefit from the highway shall pay for its construction and maintenance. Who is it that benefits? Definite economic surveys made by the Bureau of Public Roads show that in the initial improvement of the highway there is found an accretion in the value of land in the vicinity which ranges anywhere from 300 to 1,000 per cent. More important, there is the fulfillment of a human need which, while it may not be directly susceptible to economic treatment, is none the less a large factor in road construction, particularly in the agricultural regions.

Urban Valuations Increased.—Urban valuations are also increased by the construction of rural highways, because not only does the highway bring new buying power to the city but it also brings about a tremendous suburban development which is, as yet, only in its infancy.

Finally, the man who uses the highway finds his costs lessened as it is improved, or better, as it is main-

tained in a constant condition of service.

Taken in sum, these three elements represent all of the tax-paying elements of the community; hence it may be fairly said that capital charges for highway construction should be provided for from general taxation whether these payments are made in the form of amortization charges for a long term bond issue, which spreads the charge over this and succeeding generations of beneficiaries, or whether it be a special levy.

When we come to the question of maintenance, however, the problem is not as clear, as we have not had sufficient research to determine accurately all of the secondary influences of improvements upon valuations.

We do know, however, that the user of the highway is one who obtains the first service from it, that his costs are affected as the highway is kept in condition or allowed to go to pieces, and finally, that much of its depreciation is due to use.

Provides Annual Revenue.—It thus appears that the user should be charged with the upkeep of the road, a principle which is sound from a financial standpoint in that our present system of motor registration is a recurrent annual charge which automatically produces the revenue necessary to maintenance. For this reason it is fair to insist that motor fees should be set aside for maintenance rather than diverted into construction, and further, it is reasonable to demand that the administration of these funds shall be so controlled as to make the highway of the utmost service.

In conclusion, then, I should say that we cannot solve the highway finances of a country so diversified as this by any detailed formula, but we can proceed to adopt certain definite principles which may be expressed somewhat in this way.

Principles Suggested for Adoption.—Highway systems should be laid out by state highway departments, with a definite view to meet the social and economic needs of the commonwealth.

The needed revenue for construction should be secured from long term bond issues based upon general taxation, while current operating expenses should be secured from the user and should be adequate to maintain the highway once constructed.

Centralized administrative control is essential to a proper development of these systems as well as to the regulation of their use, and broad powers should be granted the state department in charge, to insure an economic flow of traffic.

It is hardly necessary to emphasize, in closing, that the need for general bond issues will be dependent upon the degree of present improvement of the system.

The problem which confronts us is one of statisfying a proven human need, the elemental desire for individual transportation, the fulfillment of which is a social as well as an economic necessity to our further progress.

The more rapidly our finances can be placed upon such a basis as this, the more rapidly will the states, as a whole, afford new opportunity for those who, living in city or country, have found themselves deprived of opportunity for free communication which should be the right of all.

Statistical Methods of the Bureau of Labor Statistics

The methods followed by the United States Bureau of Labor Statistics in procuring and computing statistical information relating to labor forms the subject of Bulletin No. 326 recently published by the Bureau. The purpose of this bulletin is to describe the principal activities of the Bureau, the functions of which are purely educational and not administrative, and to outline the methods used in making its investigations and preparing its reports.

The bulletin takes up the different subjects covered regularly in the investigations of the Bureau, giving examples of questionnaires and schedules used by agents in collecting material relating to wages and hours of labor, cost of living, retail and wholesale prices, volume of employment, strikes and lockouts, industrial accidents, and workmen's compensation and insurance. The methods used in making computations are also described and the extent of the work done in the different fields of study is given together with the sources from which this information is drawn and the scope of the various investigations. The publication of the Monthly Labor Review by the Bureau since 1915 has afforded a means of bringing much of this information before the public without the delay involved in the preparation of special bulletins.

Use of Timber in Highway Bridges

Standard Specifications for Timber Structures of U. S. Bureau of Public Roads

Specification for Timber Structures

Description.—Timber structures shall be built where shown on the plans or directed by the engineer and shall be constructed in accordance with the plans and specifications. This item shall include only such timber as is a part of the completed work. All timber for erection purposes, as falsework, forms, bracing, sheeting, etc., shall be furnished by the Contractor at his own expense.

Quality.—All timber shall be cut from sound trees, sawed standard size, straight, and out of wind and shall be free from defects such as decay, worm holes, injurious shakes, checks and crooked, cross or spiral grain, large loose or unsound knots, knots in groups, large pitch pockets, or other defects that might impair its strength and durability. Wane may show on only one corner of a piece. Wane shall not exceed one-half the length of the piece nor measure more than 1 in. across the face of the wane. Not more than 10 per cent of the pieces of one size may show any wane.

Size.—Rough timbers when sawed to standard size, shall mean that they shall not be over ¼ in. scant from actual size specified. For instance, a 12 by 12 in. timber shall measure not less than 11¾ by 11¾ in.

Dressed. Standard dressing means that not more than ¼ in. shall be allowed for dressing each surface. For instance, a 12 by 12 in. timber shall, after dressing four sides, not measure less than 11½ by 11½ in.

Dense Timber.—Dense timber shall be used for truss members, floor beams, stringers, caps and flooring.

a. Dense timber of longleaf pine, shortleaf pine and Cuban pine shall show at one end or the other an average of at least six annual rings per inch and at least one-third summer wood, all measured over the third, fourth and fifth inches on a radial line from the pith. Wide ringed material excluded by this rule shall be acceptable provided the amount of summer wood as above measured shall be at least one-half. Summer wood is the hard, dense and darker colored portion of the annual ring.

(1) In cases where timber does not contain pith, and it is impossible to locate it with any degree of accuracy, same inspection shall be made over 3 in. in an approximate radial line beginning at the edge nearest the pith in timbers over 3 in. in thickness and in the second inch of the piece nearest to the pith in timbers 3 in. or less in thickness.

(2) In dimension material containing the pith but not a 5 in. radial line, which is less than 2x8, which is in section, or less than 8 in. in width, that does not show over 16 sq. in. on the cross section, the inspection shall apply to the second inch from the pith. In larger material that does not show a 5 in. radial line the inspection shall apply to the 3 in. farthest from the pith.

b. Dense timber of Coast Region Douglas fir shall be strong timber of medium rate of growth and show on one end or the other an average of at least six annual rings per inch and at least one-third summer wood measured over 3 in. on a line located as hereinafter described. Wide ringed material, excluded by this rule, shall be acceptable provided the amount of summer wood as above measured sahll be at least one-half. Material in which the proportions of summer wood is not clearly discernible shall not be used.

(1) Any timber whose least dimension is less than 5 in. shall not show the pith on the inspection end; pieces whose least dimension is 5 in. or more may contain the pith.

(2) When the least dimension is 5 in.. or more, the pith being present, the line over which the rate of growth and percentage of summer wood measurements shall be made, shall run from the pith to the corner farthest from the pith. The 3 in. line shall begin at a distance from the pith equal to 2 in. less than one-half the least dimension of the piece.

(3) For all pieces not having the pith present the center of the 3 in. line shall be at the center of the end of the piece and the direction of the 3 in. line shall be at right angles to the annual rings.

(4) If a radial line of 3 in. cannot be obtained, the measurement shall be made over the entire radial line that is available.

Dense Timber of Other Species.—Dense timber of other species shall be close grained, solid and strictly first quality.

Cuban pine
White oak
Spanish oak from lowland
Tanbark oak.

Permissible Stresses of Structural Timber
(Revised April, 1923)

When used with this specification the following stresses in pounds per square inch are permissible for structural timbers.

NAME	Axial Tension and Bending Stress	Horizontal Shear in Bending	Compression Parallel to the Grain			Compression Perpendicular to Grain	Shear Parallel to Grain
			End Bearing	L/D 0 to 10	L/D 10 to 30		
1	2	3	4	5	6	7	8
a Locust, black	2,200	220	1,800	1,600	$1800-25\frac{L}{D}$	600	350
c Maple, sugar or hard c Oak, Spanish (lowland) b Oak, tanbark b Oak, white	1,600	150	1,200	1,000	$1200-25\frac{L}{D}$	350	220
b Pine, Cuban b Pine, longleaf	1,600	120	1,200	1,000	$1200-25\frac{L}{D}$	250	180
b Fir, Douglas (Coast Region) c Pine, shortleaf	1,600	100	1,200	1,000	$1200-25\frac{L}{D}$	250	150
b Larch, western b Oak, Pacific post b Oak, burr c Pine, loblolly c Pine, table mountain c Tamarack	1,400	100	1,100	900	$1100-25\frac{L}{D}$	240	150
a Cypress, bald b Fir, Douglas (Mountain Region) c Hemlock, western c Hemlock, eastern c Pine, Norway c Pine, pitch a Redwood	1,200	90	1,000	800	$1000-25\frac{L}{D}$	180	130
a Cedar, western red a Chestnut c Pine, western yellow c Spruce, red c Spruce, sitka	1,000	60	800	700	$900-25\frac{L}{D}$	160	120
a Cedar, white c Pine, Lodgepole c Spruce, Englemann c Spruce, white	800	70	700	600	$800-25\frac{L}{D}$	140	100

L equals length of column, and **D** equals least side or diameter, both dimensions in the same unit either feet or inches. The unsupported length of wooden columns and compression members shall not exceed 30 times the diameter of least side.

a Very durable. **b** Durable. **c** Perishable.

Sound Timber.—Timber for columns, sills, wheel-guards, bulkhead sheeting, bracing and timber for other purposes, unless otherwise specified, shall fulfill the foregoing requirements except the density rules given in paragraph No. 4.

Heart Requirement.—All untreated timber shall show at least 85 per cent heart wood on any girth.

Untreated Timber.—For designs based on a fiber stress in bending of 1,500 to 1,600 lb. per sq. in., one of the following species of timber shall be used.

Douglas fir from Pacific Coast Region
Longleaf pine
Shortleaf pine

Treated Timber.—For designs based on a fiber stress in bending of 1,500 to 1,600 lb. per sq. in., one of the following species of timber shall be used. (See accompanying table for unit stresses.)

Douglas fir from Pacific Coast Region
Longleaf pine
Cuban pine
Shortleaf pine
White oak
Spanish oak from lowland
Tanbark oak
Willow oak.

Timber treated by pressure method to retain 8 to 12 lb. of oil per cu. ft. and so treated that all sapwood is entirely impregnated with creosote oil

shall fulfill the requirements for untreated timber except that there shall be no heartwood requirement.

Construction

Handling Treated Timber.—Treated timber shall be carefully handled without sudden dropping, breaking of outer fibers, bruising or penetrating the surface with tools. It shall be handled with rope slings. Cant dogs, hooks or pike-poles shall not be used.

Cuts in Treated Timber.—All places where the surface of treated timber is broken by cutting, boring or otherwise, shall be thoroughly coated with hot creosote oil and then with a coating of hot tar pitch.

Pile Caps.—Pile caps shall be level and have full even bearing on all piles in the bent and be secured to each pile by a ¾ in. diameter drift bolt extending at least 9 in. into the pile. Parts of pile-heads projecting beyond the cap must be adzed off to a slope of 45 degrees.

Framing.—Truss and bent timbers shall be accurately cut, and framed to a close fit in such manner that they will have even bearing over the entire contract surface of the joint. No blocking or shimming of any kind will be allowed in making joints, nor will open joints be accepted. Mortises shall be true to size for their full depth and tenons shall make snug fit therein.

Bolt Holes.—All bolt holes shall be bored with an augur 1/16 in. smaller in diameter than the bolt. Mortises and tenons shall be "draw bored."

Stringers.—Stringers shall be sized at bearings. Outside stringers may have butt joints but interior stringers shall be framed to bear over the full width of floor beam or cap at each end. The ends shall be separated at least ½ in. for the circulation of air and shall be securely fastened to the timber on which they rest.

Floor Plank.—Roadway floor plank shall have a nominal thickness either of 4 or 3 in. as specified, and an actual width of not less than 9½ in. Sidewalk floor plank shall be surfaced to uniform thickness. It shall have an actual minimum width of 5½ in. and thickness of 1⅝ in.

Laying Floor Plank.—Floor plank shall be laid heart side down with ¼ in. openings and be spiked to each stringer or nailing strip with at least two 7 in. spikes for 4 in. plank and two 6 in. spikes for 3 in. plank. Rough plank shall be carefully graded as to thickness before laying, and be laid so that no two adjacent planks vary in thickness more than 1/16 in. All floors shall be cut to a straight line along the sides of the roadway and walkway.

Wheel-Guards. — Wheel-guards, as shown on the plans, shall be constructed on each side of the road. They shall be raised from the floor by blocks 8 in. thick by 1 ft. long, spaced about 5 ft. apart center to center, and be fastened in place by a ⅝ in. bolt passing through the wheel guard, each block and the floor plank.

Railings.—Railings shall be built in accordance with the designs shown on the plans, and shall be constructed in a workmanlike and substantial manner. Unless otherwise noted all railing material shall be dressed on four sides (S4S).

Pins.—Pins may be turned or split and drawn, from clear, sound wood of the kind specified on the plans. They shall be made 6 in. longer than the required finished length, and when driven into place shall have their ends sawed off flush with the surface of the member.

Turned pins shall be made from square stock sawed parallel to the grain. One end shall be left square for about 1 in. and the other shall have a dull point. The body of the pin shall be uniform in diameter and 1/16 in. larger than the diameter of the hole. The finished pins shall be free from knots, knot holes, pockets, splits or flaws which might impair their strength.

Split and drawn pins shall be made from straight grained green lumber and be allowed to season. One end shall be hardened and pointed by charring. They shall be octagonal in shape and when seasoned the diameter between parallel faces shall be the same as the diameter of the holes in which they are to be driven.

Bolts.—Bolts shall be of the sizes specified and must be perfect in every respect. They shall have square heads and nuts and screw threads shall make close fits in the nuts. All bolts shall be effectually checked after the nuts are adjusted.

Washers.—Washers shall be used between all bolt heads and nuts, and wood. Cast washers shall have a thickness equal to the diameter of the bolt and a diameter of four times the thickness. For plate washers the size of the square shall be equal to four times, and the thickness equal to one-half, the diameter of the bolt.

Preservative Treatment

Description. — Whenever specified timber and piles shall be treated for preservation, prior to treatment the piles shall be trimmed and peeled and the timber cut and framed. No cutting or trimming will be allowed after treatment except the boring of necessary holes.

The timber shall then be impregnated with the preservative specified using any standard process approved by the Engineer so that from 8 to 12 lb. of creosote oil per cu. ft. is retained and all sapwood is thoroughly penetrated.

Material.—The preservative shall be one of the following grades of creosote oil or creosote oil tar solution as directed by the Engineer, or indicated on the plans and shall meet the following requirements:

wire. After the cover is in place the cap shall be placed as described in Article No. 11.

Untreated Timbers.—In structures of untreated timber the following surfaces shall be thoroughly coated with a thick coat of red lead paint, hot tar, hot asphaltum, or hot creosote residuum before assembling. Heads of piles, ends, tops, and all contact surfaces of pile caps, floor beams, and stringer ends, joints and all contact surfaces of truss members, laterals, and braces.

The back face of bulkheads and all other timber in contact with earth shall be thoroughly coated with one of the materials specified above, or a carbolineum.

Railings.—Unless otherwise specified railings shall be made of untreated dressed lumber and shall be

Preservative Specifications

	Creosote Oil			Creosote Coal Tar Solution
	Grade 1	Grade 2	Grade 3	
1—It shall not contain water in excess of	3%	3%	3%	3%
2—It shall not contain matter insoluble in benzol in excess of	0.5%	0.5%	0.5%	2.0%
3—Specific gravity of oil at 38°/15.5°C, shall not be less than	1.03	1.03	1.03	1.05—1.12
4—The distillate based on water-free oil shall be within the following limits:				
Up to 210°C, not more than	5%	8%	10%	5%
Up to 235°C, not more than	25%	35%	40%	25%
5—The float test of residue above 355°C shall not exceed 50 sec. at 70°C, if the distillation residue above 355°C exceeds	5%	5%	5%	26%
6—Coke residue of oil not more than	2%	2%	2%	6%
7—The foregoing tests shall be made in accordance with standard methods of A. S. T. M. Designation D38-18.				

Painting

Treated Timbers.—Hot creosote oil shall be poured into the bolt holes before the insertion of the bolts, in such a manner that the entire surface of the holes shall receive a coating of oil. After the necessary cutting and sloping of projecting parts has been done to receive the cap, the heads of piles shall be given three coats of hot creosote oil. They shall then be covered with a coat of hot tar pitch over which shall be placed a sheet of 3-ply roofing felt or galvanized iron, or a covering may be built up of alternate layers of hot tar pitch and loose-woven fabric similar to membrane waterproofing using four layers of pitch and three of the fabric. The cover shall measure at least 6 in. more in each dimension than the diameter of the pile and shall be bent over the pile and the edges fastened with large headed nails, or secured by binding with galvanized

painted with two coats of paint composed of 85 per cent pure white lead and 15 per cent zinc white mixed in pure raw linseed oil.

Bolts.—All bolts passing through non-resinous wood shall be painted with two coats of red lead paint at least 85 per cent pure.

Basis of Payment.—This work will be paid for at the contract unit price per thousand feet board measure for untreated timber or treated timber, as the case may be, complete in price according to the plans or as directed by the Engineer, which place will include all materials, excavation, equipment, tools, labor, painting, preservative treatment and all work incidental thereto. No additional allowance will be made for spikes, nails, bolts, washers, drift bolts, etc.

In computing the quantity of timber, nominal sizes will be used.

Sheet Asphalt Construction in Little Rock, Ark.

By W. E. FORD,

Ford & MacCrea, Consulting and Supervising Engineers, Gazette Bldg., Little Rock, Ark.

Street Improvement District Number 313, embracing the paving of about nine blocks in the southern part of the city of Little Rock, Ark., was inaugurated principally to connect up several streets which had already been paved, and to accommodate the residents of this section which is the centre of many attractive homes.

The new construction is sheet asphalt throughout and measures 36 ft. between curbs. The street corners have been changed to an 8 ft. radius so as to facilitate the turning of long wheel base cars and to give ample parking space on the street.

As it was not expected that these streets would receive very much of the extremely heavy traffic of the city, and since the sub-soil was of a more or less stable character, with drainage very well taken care of, the concrete base was made 5 in. thick with a uniform 1:3:6 mix, and was slightly roughened on the surface to receive the asphalt binder.

The writer has observed that the most successful asphalt pavement is the one that receives maximum compression. In order to obtain a tightly compacted sheet asphalt pavement in this district, we chose a binder course measuring 1½ in. before rolling and 1 in. after rolling. The wearing surface measured 1¼ in. before rolling and was reduced to 1 in. by rolling.

The stone used in the concrete base was blue trap rock furnished in sizes ranging from ½ to 1¼ in. Sharp, coarse sand taken from the Arkansas River was used to complete the mineral aggregate of the base. Blue trap rock in a smaller size was used in the binder course, and selected sand from the Arkansas River was used in the wearing course. Texaco No. 54 asphalt paving cement was used in the construction of binder and top for the entire job.

The contractor who handled the construction of base, curb, drainage, etc., was the Oliver Construction Co., and the Standard Paving Co. of Little Rock laid the asphalt top.

Twenty-first St., Little Rock, Ark., Paved in February, 1923, With Sheet Asphalt.

Street Railway Track in 26 ft. Parkway.—In paving 7th East St. at Salt Lake City, Utah, a new departure in paving design was used in the center parking for the tracks of the Utah Light & Traction Co. between 5th and 9th South. By this method the car company maintains its right-of-way within a 26-ft. park sown in grass, and in the construction of the pavement pays for the cost of the park, curb and sidewalk landings at each end of the park. This way of paving quite materially reduces the cost of the improvement.

Patrol Method of Road Maintenance

System of Michigan for State and County Roads Described in Paper Presented June 12 at Annual Convention of Canadian Good Roads Association

By L. H. NEILSON,
Deputy State Highway Commissioner of Michigan.

This paper is written from the standpoint of practices developed from the experience of Michigan in handling the maintenance of her state trunk line road system through the county road organizations and in the methods developed by the Michigan counties in handling their state aid county systems. Opinions expressed and methods suggested are those best adapted to Michigan's soil, climate, traffic and other conditions.

Michigan Plan of Maintenance.—Under our laws the counties pay from 5 per cent to 25 per cent of the cost of construction and from 10 per cent to 50 per cent of the cost of maintenance. The state highway department lets the contracts for construction, and the counties handle the maintenance of the state line highways under an agreement providing for the return of the state's share based on quarterly statements of the cost of doing the work. The county maintenance organization handles the upkeep of both the state trunk lines and the county roads, thus saving duplication of overhead and equipment expense.

The present maintenance organization is headed by the state highway commissioner through his maintenance department which supervises the county organizations handling the work. The state is divided into nine engineering districts with a district engineer in charge, who handles all the work of the department in the group of counties under his supervision. He has assistants, one of whom is especially charged with supervision of maintenance work. The county road work is handled by a board of county road commissioners consisting of three members whose duties are administrative and who must hire an engineer or superintendent skilled in roadbuilding to handle all construction and maintenance.

The roads must lie on a county system approved by the state highway commissioner if state aid is desired. The qualifications of the county highway engineer must be approved by the state highway commissioner. The engineer must also be registered under the state law, providing for registration of engineers.

Where the county road system is extensive enough and the expenditures are large enough to warrant it a superintendent of maintenance, reporting to the county engineer is employed. Sometimes a county is divided into several districts with an overseer over each district who has direct charge of the patrolmen.

Agreement with County.—Under the system now in effect in Michigan a contract or agreement is drawn up with the county authorities covering the work for the ensuing calendar year. Each patrol section is listed with the men, equipment, material and money required to properly maintain it. To the total cost shown for the several sections is added the proper supervisory or overhead cost, the salaries of the superintendent and overseers and equipment rental or allowance. The agreement shows the share provided by law which shall be refunded by the state on the receipt and audit of the quarterly statements. Any extraordinary or emergency expenditure which would run the cost of any section or sections above the amount budgeted in the agreement must be approved by the district engineer and by the maintenance department before the work is done in order to be audited and approved in a quarterly statement.

Marking the trunk line routes with the proper numbers, direction and warning signs is done by the department crews and the cost charged back to the counties. Certain bridge repairs and steel bridge painting are handled by department gangs.

Each year estimates are gathered covering the amount of tars, asphalts and calcium chloride to be used for the season and bids taken for supplying the needs of the country organizations for these materials. Purchases are made for both county roads and state trunk line highways. Large savings have been made possible by this method. Another feature which

is extremely important is that this blanket letting enables the setting up of a standard specification which all bidders, whatever may be the trade name of their product, are forced to meet. Tests are then made of the materials as furnished and it has been possible to secure uniform materials for the several kinds of work, such as surface treatment, penetration macadam, cold patch and joint fillers for concrete pavements.

Maintenance and construction work are now supervised by a landscape engineer with special reference to the preservation and planting of trees, shrubs, etc., so as to make the roadsides more pleasing to the eye.

Maintenance of Gravel Roads.—Inasmuch as 50 per cent of the 6,045 miles of the trunk line system, under maintenance in 1922, are gravel surfaced and more than 70 per cent of the state roads are of the same character, it follows that gravel road maintenance is of primary importance.

On earth and gravel surfaces particularly, the patrolman is the fundamental unit upon which the whole organization is built up. He is placed in charge of a section, the length of which depends on the character of the improved road and the amount and kind of traffic to be carried. The usual section is 3 to 5 miles. He is responsible to his superior for the condition of the road surface, for the safety of the traveling public, for the legibility of markers, warning and direction signs and for the general appearance of the roadside. He should live near the center of his section if possible. The endeavor should be to secure and retain men who will stick to the job. Compensation should be on a monthly basis and should be based on results and increased with length of service. Work of this character cannot be done according to rigid specifications laid down in advance because of the widely varying nature of the soils, road surfaces and kind and character of traffic. It is therefore very essential that the job be made attractive to the man who will be observing and resourceful as well as a willing worker.

All necessary equipment should be furnished to the patrolman, who must be responsible for it while assigned to his section.

The first care of the patrolman must be to keep the road surface as near perfect as possible. He should begin work as soon as the frost is coming out of the ground in the spring. Early in the season it is often advisable to supplement his efforts with some gang work involving the use of heavy graders drawn by tractors to shape the road surface at the time it is most easily handled. Sod ridges formed on the shoulders through the preceding summer can easily be removed and the true cross section restored. All oversize stone should be removed before new material is added.

The early gravel roads were built without much regard for the size of stone or the sand, loam or clay content of the material. A large amount of oversize makes it next to impossible to keep a smooth surface. The present specifications call for a maximum size of ¾-in. with 75 per cent retained on a screen having eight meshes to the linear inch. The problem of keeping a smooth surface on such roads is very much simplified. Too large a percentage of clay has resulted in roads that mud up and become rutted and rough. The maximum clay tolerance is 10 per cent and there must be no lumps. In pits with a large amount of oversize the bank gravel is usually crushed so as to utilize all the material handled. All depressions and ruts should be kept filled. The gravel should be shovelled out of the truck or wagon unless a considerable amount is required when it can be best dumped out of an end dump truck.

New material should be available along the roads if the source of supply is at a considerable distance. Stock piles should be placed outside the shoulder lines and back of the ditches.

Dragging Essential.—Dragging should be done with a patrol grader or truck scraper. Good results can be secured with mechanical power but care must be taken to keep the speed down. Teams are very satisfactory because the speed can be kept down but often are too expensive because they can cover only limited mileage in a given time. Material must be added as fast as it is worn away and in sufficient amounts to leave a little to be moved into the ruts and depressions as the grader moves over the road. Where traffic is heavy it often becomes necessary to drag once or even twice a day regardless of weather conditions.

With an adequate patrol maintenance system in operation the crown

should be kept from 4 to 6 in. in 24 ft. This may be made a little higher as fall rains come and flattened out after the spring rains are over.

Resurfacing is required periodically and care should be taken to use clean, properly prepared material, free from clay or loam, with a maximum size of ½ in. or ¾ in. The large amount of pleasure car traffic on our main traveled highways is making the elimination of dust imperative. Good clean patching and resurfacing helps to accomplish this.

Heavy resurfacing work should be done early in the spring or late in the fall so that the traveling public will be as little inconvenienced as possible.

Calcium chloride has been used with very good success as a dust layer both in the flake and the granulated form.

Income from Long Term Contracts

Methods of Reporting for Income Tax Purposes Described In The Constructor

By E. J. BROSNAN,
Assistant Treasurer, Associated General Contractors

The construction industry presents some peculiar difficulties in the calculation of net income from contracts extending over a period of more than one year.

While the Treasury Department permits the filing of income tax returns in accordance with the accounting methods employed by taxpayers, provided such method clearly reflects the net income, in the case of contractors whose income is largely derived from contracts extending over a period of years, it goes a little further and suggests other methods for reporting net income which is optional on the part of the contracts to follow.

Two Suggested Methods.—The suggested methods for the determination of income from long-term contracts, are as follows:

a. On the basis of percentage of completion.

b. Income may be reported in the year in which the contract is finally completed.

If a taxpayer decides to file his return on the basis of percentage of completion there should accompany the return certificates of architects or engineers showing the percentage of completion during the taxable year, of the entire work to be performed under the contract. Deduction from the gross income thus determined should be made of all expenditures made during the taxable year in connection with the contract, including reasonable allowances for depreciation and other losses on machinery and equipment.

Adjustments should be made on account of any materials or supplies remaining on hand at the beginning and end of the taxable period for use in connection with the contract.

If, after the contract is completed and it is found that the net income has not been clearly reflected for any one year or years, it is permissible to amend the returns so as to show the correct income accruing from the contract. The Commissioner of Internal Revenue may, if in his opinion the net income is not clearly reflected under this method, requir that amended returns be filed.

The above method is probably the most complicated and one that would require many supporting statements and a great deal of correspondence with the Treasury Department, which it is desirable to avoid. The other method suggested by Regulation 62. on the completed contract basis, is probably the most logical to follow.

Completed Contract Method.—The completed contract method provides for the reporting of income only after the completion and acceptance of the contract. Contractors are advised to choose this method for filing their return of net income, for it is the most accurate and precludes the mistakes incident to filing on a percentage of completion basis. At best, the income thus reported would have to be estimated, resulting in later adjustments either by request of the Treasury Department or voluntarily by the taxpayer in case the estimated income is found to be incorrect.

On the completed contract basis, a return of income is not made until all work has been completed. This affords the taxpayer ample time to make all the necessary adjustments in his accounts, to include all expenditures made at any time, in connection with the particular contract, and to arrive at an accurate profit or loss arising from the contract.

The regulations on the subject require the deduction from gross income of all expenditures made in connection with the contract, adjustment being necessary for any materials and supplies originally charged against the

contract but remaining on hand at the time of completion.

An Example.—A question which should be of interest to contractors has arisen in connection with a case in which the writer is interested. A contractor engaged on a State contract expending over a period of three years, finished the physical work in the fall of 1918. A final estimate was not received, however, until 1919. The taxpayer in question, having elected to file his return on a completed-contract basis, contends that the contract was not completed until the work had been approved and a final estimate made by the State Engineer. In this particular case it would appear that the terms of the contract and the method of bookkeeping employed by the taxpayer would be the determining factors. Assuming that there was no provision in the contract as to the final approval of the work, and the taxpayer, following a consistent practice of keeping his books on an annual basis, had set up as an accounts receivable, the amount of the contract then, in accordance with Office Decision 6B, quoted below, the income would be taxable in the year in which the book entry was made.

Office Decision No. 1147, dealing with this subject, reads as follows:

"A taxpayer, reporting income on the completed contract basis, who keeps his books of account on an annual basis, and who, upon completion of the contract extending over a term of years, receives a part payment called for therein, the balance being represented by an accounts receivable, should return the full amount of the contract price as income for the year in which the contract was completed."

No decision has as yet been rendered by the Bureau of Internal Revenue in the case cited above, and a decision in favor of the taxpayer should be of vital interest to contractors on account of the reduction in the rates of tax in the year 1919.

Any contractor who has previously filed his return in accordance with his method of bookkeeping may change to either of the methods above outlined. In case a change is made, the Government requires a statement showing the composition of all items appearing upon his balance sheet and used in connection with the method of accounting formerly employed by him.

Warrants.—In some localities it is the practice to issue warrants in payment of work performed on contracts with cities, towns, etc. In such cases, the regulations provide that the fair market value of such contracts should be returned as income. If, however, upon conversion of the warrants into cash the value thus returned is not realized, a deduction of the difference is permissible from the gross income for the year in which the warrants were converted into cash. In case a greater amount is realized, such amount should be included as income for that year.

Concrete Road Surfacing by "Rhoubenite" Process

Experiences in Belguim Described in Paper Presented May 9 at 4th International Road Congress, Seville, Spain

By MESSRS. CLAEYS, GOORIECKY and MULHEN

Ingenieurs Principaux des Ponts et Chausees, Belgium

The inventor of Rhoubenite endeavored principally to arrive as a better impermeability. For quick setting cement the contraction produces the formation of pores and voids, which, although small, however allow the humidity to penetrate. Water in the interior prevents the free expansion and contraction of the concrete and if it freezes it breaks the cohesion of the cement and causes cracks and crevices. In order to obtain impermeability, a coat of cement or tar could be applied, but if the traffic is heavy it would deteriorate rapidly without counting that it would constitute a very costly element for this kind of surfacing which is already very high priced. With a view to finding this impermeability the inventor of Rhoubenite adds to the concrete very fine sawdust chemically neutral but compressible and of a considerable power of absorption, to which a tarred mixture is added, the impermeability of which is carefully studied.

It results from laboratory tests, which practice has proved that the resistance to compression of Rhoubenite concrete is sensibly equal to that of ordinary concrete of the same proportions and consequently, it appears proven that Rhoubenite powder does not provoke chemical reactions which would oppose the setting. This property it seems may be explained in the following way: at the moment when the powder is incorporated with the

concrete and during the first period of setting, the tarred product remains impregnated in the sawdust and does not intervene in the setting. Later the tarred product, under the action of expansion and contraction partially excedes the sawdust and fills the pores which were produced by the evaporation of the water and the completion of the setting, what is more, the sawdust acts as an elastic body in the concrete.

By using Rhoubenite powder, mixing it well, satisfactory impermeability is attained and the tendency to the formation of cracks is considerably reduced. The rolling of the sawdust is not to be feared because it is compressed in the mass, sheltered from the inclemencies of the weather and saturated as it is with tar.

Rhoubenite Powder.—The exact proportion of the elements and the mixing temperatures are the secrets of the inventor.

The powder has the property of not agglomerating, even if it rests for a long time in heaps. With time it not only does not lose its qualities but it improves.

Making the Concrete and Execution of the Rhoubenite Surfacing.—The proportions are:

Gravel	1.100 dcm³.
Sand or dust	450 dcm³.
Cement	400 kgs.
Rhoubenite powder	60 liters.

The quantity of water is approximately 160 liters; an excess of water should be avoided, as this might produce voids in the mass when evaporating. The mixture is made in concrete mixers, taking the precaution not to add the Rhoubenite powder before the concrete is thoroughly mixed. The old macadam having been picked and rolled the concrete is spread on a thickness of 12 cm., so that after ramming it preserves a thickness of 10 cm. The ramming is carried out by means of square iron rammers or with a light roller, preferably of the tandem type with 5-ton wheels, exercising a pressure of 20 kilos per cm² of width of rim.

Traffic must be stopped during two or three weeks.

Interruption Joints in the Work.—The junction of the fresh concrete with the hard concrete of the day before was made during the first applications at right angles to the axis of the road. These joints by reason of the setting constitute weak points and because of alternate periods of dry and damp weather and more especially because of frost the form hollows very trying for the traffic. By making these joints obliquely it is easier for the traffic but the real difficulty is not overcome. The authors of this paper think that a good result would be obtained by making provisional joints formed by a line of bricks or wooden blocks until the definite setting of the concrete, and then taking them away and filling the space with Rhoubenite rich in cement or with asphaltic mixtures.

Crevices. — Although Rhoubenite possesses properties of elasticity superior to those of ordinary concrete, it is not, however, possible to prevent certain stresses from arising which localize and give rise to tensions surpassing the elastic limit. Thus crevices are produced, fairly rare during the first applications of the system, Mr. Mulhen's opinion being that as the execution of the work was carried out on sections very slightly longer than the width of the roadway, the interruption joints had the effect of localizing the contraction stresses due to the setting. The methods of rapid construction having been improved the length of the day's work is considerable and the crevices are much more frequent and because of this provisional joints have been used always with the object of preventing the formation of cracks.

Repairs.—Besides the joints and the cracks which constitute the weak points, disaggregations are produced resulting sometimes from the presence in the gravel of soft or porous elements, sometimes from accidental defects in the mixing of the concrete or again the dilution of the Rhoubenite recently placed by sudden rain, or else by the setting being upset by a sudden frost. The disaggregations are more important when the gravel is calcareous; they are also important when it is sandy by reason of its lack of homogeneity. Consequently a hard, not porous and homogeneous gravel should be chosen.

The repairs of the cracks like those of hollows must be carried out by cutting the surface on the whole of its thickness, trimming and cleaning the old concrete before filling in with the fresh concrete, which should be well rammed.

Standard Tests for Non-Bituminous Material

In its report submitted at the annual convention of the American Society for Municipal Improvements, the committee on "Standard Tests for Non-Bituminous Materials," of which Prof. Arthur H. Blanchard is chairman, recommended that the society adopt the following fifteen methods of testing, as standards of the Society:

Apparent specific gravity of sand, stone and slag screenings, and other fine non-bituminous highway materials, as described in the Am. Soc. Test. Mat., 1921 Standards, pages 715-718, and designated D 55-19.

Apparent specific gravity of coarse aggregates, as described in the Am. Soc. Test. Mat., 1921 Standards, pages 713, 714, and designated D 30-18.

Mechanical analysis of sand or other fine highway material, as described in the Am. Sos. Test. Mat., 1921 Standards, pages 721, 722, and designated D 7-18.

Mechanical analysis of mixture of sand or other fine material with broken stone or broken slag, as described in the Am. Soc. Test. Mat., 1921 Standards, page 724, and designated D 19-16.

Mechanical analysis of broken stone or broken slag, as described in the Am. Soc. Test. Mat., 1921 Standards, page 723, and designated D 18-16.

Abrasion of road material, as described in the Am. Soc. Test. Mat., 1921 Standards, page 710, and designated D 2-08.

Toughness of rock, as described in the Am. Soc. Test. Mat., 1921 Standard, pages 711, 712, and designated D 3-18.

Crushing strength of rock or slag, as described in the Am. Soc. C. E. Trans., Vol. 82, 1918, page 1442.

Cementation of rock, slag, and gravel powders, as described in the Am. Soc: C. E. Trans., Vol. 82, 1918, pages 1441, 1442.

Quantity of clay and silt in gravel for highway construction, as described in the Am. Soc. Test. Mat., 1921 Standards, page 719, and designated D 72-21.

Organic impurities in sands for cement concrete, as described in the 1921 Report, Com. C-9, Am. Soc. Test. Mat., page 12, and designated C 40-21 T.

Tests for portland cement, as described in the Am. Soc. Test. Mat., 1921 Standards, pages 530-547, and designated C 9-21.

Compression test of cement concrete, as described in the 1921 Report, Com. C-9, Am. Soc. Test. Mat., pages 6-11, and designated C 39-21 T.

Paving brick rattler test, as described in the Am Soc. Test. Mat., 1921 Standards, pages 567-574, and designated C 7-15.

Absorption of water by wood blocks after treatment, as described in the Am. Soc. C. E. Trans., Vol. 82, 1918, page 1447.

The Committee also recommended that the Society tentatively adopt, until the 1923 Convention, the following methods of testing:

Decantation test for sand and other fine aggregates, as described in the 1922 Annual Report of Committee D-4, Am. Soc. Test. Mat., and designated D 136-22 T.

Consistency of portland cement concrete for pavements or for pavement base, as described in the 1922 Annual Report of Committee D-4, Am. Soc. Test. Mat., and designated D 138-22 T.

Sampling stone, slag, gravel, sand and stone block for use as highway materials, as described in the Am. Soc. Test. Mat., Proc. Vol. XX, Part I, 1920, pages 789 to 795, and designated D 75-20 T.

Mechanical analysis of subgrade soils, as described in the 1922 Annual Report of Committee D-4, Am. Soc. Test. Mat., and designated D 137-22 T.

Trade Publications

Tractor Operations.—A portfolio of snap shots showing Tioga tractors at work on jobs of various kinds has been issued by The Tioga Tractor Co., Arlington, Baltimore, Md. The illustrations show the tractors on excavating jobs, in road grading and special hauling jobs. Some interesting hitchups are shown.

Paving Mixers.—A 48 page catalog devoted to description and illustrations of Koehring heavy duty pavers has been published by the Koehring Co., Milwaukee, Wis. The catalog describes the various features of mixers and gives their specifications. It includes photographs of interesting construction operations on which the mixers are being used.

Road Building and Earth Handling Machinery.—The Russell Grader Mfg. Co., Minneapolis, Minn., has issued a 64 page catalog illustrating and describing its line of road building and earth handling machinery, including road machines, scrapers, elevating graders, conveyors, culverts, drag lines, crushers, screens, gravel equipment, etc., etc.

Mixers, Trenchers, Bucket Elevators, Etc.—A condensed catalog of the Austin Line of construction equipment has been issued by the Austin Machinery Corp., Toledo, O. It includes, illustrations and concise description of mixers, trenching machines, road tamper, asphalt plant, back filler, wagon loader, crane-shovel, and drag lines. Operating data and dimensions of each machine are given.

Water Works

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.
221 East 20th St., Chicago

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LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 904 Longacre Bldg., 42d St. and Broadway
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Vol. LX. CHICAGO, ILL., JULY 11, 1923 No. 1

"Why Not Meter Air?" Asks Ald. Byrne

At last the leading newspapers of Chicago have begun advocating the metering of all water consumers. The mayor has advised this action, and Alderman Eaton has introduced a motion to effect city-wide installation of water meters. Whereupon up rises Alderman Byrne to protest in behalf of his constituents, and thus he speaks:

"Where is all this going to stop? Ald. Eaton (Fifth ward, who sponsored the motion) comes from a gold coast ward where every family has its icebox. In my ward we don't and can't have iceboxes because we're too poor. Are you going to stop the kiddies from having a drink of water or keep the poor mother from cooling her food in this hot weather.

"You've taken away our beer and now you want to take away even our drinking water. You've got the biggest lake in this part of the country right at your door and yet you want to meter it. You might as well meter the air."

To which last thrust the Chicago Evening Post replies that it would be wise to meter the air if it were as expensive as water. Unintentionally, perhaps, Ald. Byrne gives a clue to the cause of much of the water waste when he says "we can't have ice boxes because we're too poor," for it is the practice of many water consumers to keep the faucets open continuously in the summer in order to get cold water. But if the taxpayers wish to furnish cold water to those who can not afford to buy ice, it will be found cheaper to furnish free ice to that part of the population than to continue the general waste of water.

Alderman Byrne does not oppose metering gas, yet Chicago has huge coal deposits almost at its door. He realizes that it costs money to mine, transport and deliver coal, not to mention manufacturing it into gas and piping it to consumers. He evidently does not realize that it costs a huge sum of money to pump and transport water to consumers.

Every Town Should Chlorinate Its Water

There are 2,800 cities in America having a population of 2,500 or more, and 7,500 having a population of 1,000 or more. The total number of incorporated towns is 13,000. Before these figures are considered it is impressive to read that there are 2,000 chlorinating machines in use in America, but since every incorporated town should chlorinate its water to prevent typhoid it is evident that chlorination is only just beginning to receive adequate recognition.

In an article entitled "Official Manslaughter" the reader will find reference to a recent court decision holding a city liable for damages because of typhoid infection caused by the use of "raw water." A few more such salutary decisions may hasten the day when every water supply is chlorinated. The cost of chlorination is nominal, and there is no valid excuse for failure to use this precaution against typhoid.

Politics in Government Engineering

Editorial in Chicago Journal of Commerce

The dismissal of Arthur P. Davis, director of the United States reclamation service, is discouraging to business men, to friends of reclamation and conservation and to all acquainted with the facts involved, except, of course, the politicians who engineered that dismissal.

Mr. Davis has served the Government faithfully for 40 years. He has achieved a world-wide reputation as an engineer. He has worked for a pittance and for the love of the work —encouraged in no small degree, of course, by the fact that his has been a civil service position and its permanency unquestioned. The problems of his department are entirely engineering problems and its work is done solely by engineers.

Some indefinite and intangible force suggested the appointment to the place of a country banker from Idaho, a man who had once been governor of his State, who undoubtedly is an estimable gentleman, but whose training and experience no more qualify him to succeed Arthur P. Davis than they do to understudy for Muratore.

Mr. Davis could not be discharged, so resort was had to the device of abolishing his position. Appropriation for and legal designation of a director of the United States reclamation service was discontinued and the title of commissioner was substituted. The gentleman from Idaho was appointed to fill the place.

Humiliating as the incident must be to Mr. Davis, it is a blessing to him. He has now lost all his illusions and is free to enter the larger field of a consulting practice for corporate clients who will pay him many times the meager salary provided by the Government. It is, however, a destructive blow at Government service. It undermines confidence and removes the incentive that has inspired thousands of technical men to remain true to their ideals and give their best to government service for beggarly salaries.

It is too late for President Harding to correct this particular blunder. It is highly probable that he knew nothing of the change and that, had he known of it, he would have counselled against or forbidden it. It is not his manner of doing business. He can, however, send his Cabinet members and department heads a brief message that will forefend against a repetition of the incident.

Metering Chicago's Water Supply

Editorial in Chicago Evening Post

Ald. Byrne voiced the reaction of the unthinking when he rose to protest indignantly against the proposal to meter water in Chicago. "Why not meter air?" he asked, with the obvious rhetorical appeal.

Probably if air had to be pumped through mains and pipes into every house, apartment and business building in the city, we would find it necessary to meter it in order to insure everybody at all times a sufficient supply at a fair cost. We may be thankful that is not necessary. Each human being is his own pumping station for air, and can make direct connection with the source of supply.

A parallel between water and air does not exist.

Let Ald. Byrne and colleagues of like prejudice do their constituents the justice of giving a little thought to this problem. It may require more effort, but it will serve better the interests of the men and women who

voted for them than mere indulgence in oratory.

The experience of big cities in which the meter system has been adopted shows that the result is not limitation of use, but limitation of waste; not increase of cost to the consumer, but reduction of cost to consumers and taxpayers.

Faucets carelessly left running, neglected leaks in plumbing and mains, loss through friction induced by the necessity of attempting to force through the mains a larger volume of water than they can properly carry, are all occasions of waste which runs into immense sums of money coming out of the pockets of the people.

The Chicago bureau of public efficiency, in an exhaustive report compiled in 1917, showed that under effective control, such as may be obtained through metering, a reduction could be effected in ten years' time from the 1916 pumpage of 645,000,000 gals. a day to 425,000,000 gals. a day. In other words our waste, as estimated then, was 220,000,000 gals. a day, or more than one-third of the total pumpage. One-third of what Chicago was paying for pumpage was being paid for water nobody was using.

This proportion holds good today.

The point that needs to be emphasized is that metering is not intended to reduce the quantity of water actually used, but to eliminate the expense of constructing, enlarging, maintaining and operating plants to supply the more than one-third which is wasted.

Many Chicago neighborhoods experience the annoyance of low water pressure. It is not only an annoyance; it is a peril. In case of fire it is likely to result in disaster.

This low pressure, which gives but a trickle on floors above the first, is not due to lack of supply. As Ald. Byrne says, "There is Lake Michigan!" It is not due, primarily, to inadequate equipment. It is due to waste. It is due to the fact that an equipment which would be adequate to maintain all needed pressure at a pumpage of 425,000,000 gals., is unable to pump efficiently the extra 220,000,000 gals. which are wasted.

If this waste is not eliminated more pumping stations, cribs, tunnels and like equipment must be provided in order to get the pressure which is necessary for satisfactory service and for the safety of property. That means immense expenditure which must be paid for out of rates and taxes.

Chicago must choose between conservation and waste.

Conservation means having all you need when you need it, and paying only for what you use.

Waste means the mere enjoyment of the liberty to be thriftless, with the inconvenience and peril of low pressure, and the high cost of paying for the hundreds of millions of gallons which merely drip, trickle and run away.

This is the real issue. Intelligent aldermen will discuss it; intelligent citizens will support such aldermen.

Mayor Dever is to be thanked and congratulated upon putting the question squarely up to Chicago.

Official Manslaughter

Editorial in The Canadian Engineer

Failure of municipal officials to safeguard their water supply may result in civil suit for negligence, now that a California case establishes precedent for such legal actions.

In June and July, 1920, there were about 150 cases of typhoid fever in Pittsburgh, Calif. Investigation established the fact that due to lack of a stock of liquid chlorine, the water supply from the Sacramento River was pumped into the mains for at least one day without being sterilized, and an epidemic followed. Eighteen of the typhoid victims pooled their interests and sued the city for damages, accusing the officials of neglect in failing to take reasonable precautions to purify the water supply. The plaintiffs were awarded $32,821, the largest individual amount being $12,500.

There will undoubtedly be an increasing number of successful damage suits of this nature against municipal officials and water companies. In cases where the supply is commonly known to be of a dangerous or potentially dangerous character, and where the danger has been called to official attention, it would seem that not only civil suits but even suits for criminal negligence would be well founded. Surely the official who knowingly permits a questionable water supply to be served to a community, without having taken every

possible step to remove danger of death from typhoid, is just as criminal in his negligence as is the reckless motor driver who is jailed for manslaughter.

Engineers Protest Removal of Davis as Director of U. S. Reclamation Service

Engineers are protesting strongly against the removal of Arthur P. Davis as Director of the U. S. Reclamation Service. Secretary Work's action is characterized as prejudicial to the public interest, and the Secretary is described as pursuing a dangerous course.

The Federated American Engineering Societies have raised formal and vigorous objection to the displacement of Director Davis. The position of the federation is explained in the following statement by Executive Secretary L. W. Wallace:

"The Federated American Engineering Societies has a membership of 28 engineering societies. They are local, state and national in scope and have headquarters in 24 cities of the United States. The combined membership of these 28 societies is 50,000 engineers. The engineers represented through the 28 societies formed the Federated American Engineering Societies in order that they might have an agency through which to give expression to the views of engineers regarding the public questions of an engineering aspect.

"The sole purpose for which the organization was formed is that of enabling engineers of the United States to render an essential public service. Its reports on 'Waste in Industry' and 'The Twelve-Hour Shift in American Industry' are expressions of the way in which the organization has been functioning in the interest of the public. It has also functioned in relation to certain national legislation and activities of Governmental bureaus, all of which has been done for the sole purpose of being of service to the American public.

"The recent change made in the Director of the Reclamation Service, therefore, comes within the purview of this organization and many other engineering and technical groups. The officers of the Federated American Engineering Societies, as well as the officers and members of many engineering and technical groups, are much concerned with the recent announcement relative to the displacement of the Director of the Reclamation Service and appointing in his stead a man who apparently is not technically trained and fitted to direct an important technical service of the Government.

"This procedure is looked upon with grave concern by the engineers and technical men of the United States, because such summary action as discharging an eminently successful employee after 35 years of service without a hearing or adequate explanation, and with a request to hand in his resignation to take effect within two weeks will undermine the morale of all the technical agencies of the Government and may lead the most competent men to more readily accept of engagements with commercial and industrial agencies, thus interfering with the efficient operation of the technical bureaus of the Government.

"If it is true, as has been reported, that certain Governmental officials believe that a man not technically trained and fitted is more competent to direct a technical bureau than one so trained is correct, then, indeed, such action as has taken place regarding the Reclamation Service might be reasonably expected to occur in other technical branches of the service, such as the Bureau of Mines, the Bureau of Standards and the Geological Survey as examples.

"Members of engineering and technical bodies are not willing to believe that such policy is a wise one and is in the best interest of the American people. Many technical directors of large works both within and without the Government Service, have ably directed such projects both from a business point of view as well as from a technical one.

"One of the marked tendencies in recent years has been the placing of technical men in charge of large industries and commercial enterprises. The managing directors or presidents of many large public utility companies, railways and industrial organizations are technically trained men. Therefore, the step taken in connection with the Reclamation Service is contrary to the policy of many industrial organizations.

"Because of the far-reaching re-

sults that might ensue and because of the seriousness of the situation, the organized engineers and technical men of the United States are preparing to make a thorough search into the considerations that led to the action taken in regard to the Reclamation Service. The American Society of Civil Engineers has appointed a special committee to investigate the matter. The Public Affairs Committee of the Federated American Engineering Societies, of which J. Parke Channing of New York is chairman, has already addressed a letter of inquiry to the Secretary of the Interior concerning the action.

"This is being done not from the standpoint of questioning the right of a Governmental official to discharge anyone that he may elect, but from the point of view of the wisdom of the announced policy that a technical bureau can be more effectively directed by a man not technically trained and fitted in comparison with one so technically trained and fitted.

"The work of the Reclamation Service is essentially engineering and technical. There are business aspects, to be true, but so far as is known there has been no criticism of the business direction of the Service, other than perhaps by certain interests in the West who have endeavored to secure a reduction in or have endeavored to repudiate payments for reclaimed lands purchased.

"Should this demand prevail, the fundamental principle of the enabling act will be displaced and the revolving fund for the continuation of the work will be dissipated, so that other needed projects cannot be carried out unless there be additional drains upon the Treasury of the United States. Furthermore, should such an eventuality ensue public confidence in the integrity of the direction of such work would be so shaken as to make it difficult to secure appropriations from Congress to extend the work of reclaiming the arid lands of the West.

"In the main, the support for such has come from the West, but should there be a question as to the wisdom with which the projects are selected and executed then it is entirely probable that the West would not receive support from other sections of the country. Therefore, not only is the morale of the technical service at issue, but also the larger thing, perhaps reclamation itself.

"It is these considerations that are causing organized engineers and technical men to make a thorough study of the situation. Undoubtedly pronouncements will be forthcoming as the result of such study. The evident interest and concern among engineers and technical men regarding this situation, as well as their views, may be gleaned from the strong editorials that have and are appearing in the technical publications regarding it."

Iodine Treatment of Water to Prevent Goitre

Plan of Rochester, N. Y., Described in Paper Presented May 23 at Annual Convention of American Water Works Association

By BEEKMAN C. LITTLE
Superintendent of Water Works, Rochester, N. Y.

The Water Bureau and Health Bureau of Rochester, working together, believe they have evolved a plan for successfully treating and preventing goitre. With great emphasis on the latter, for prevention is the high ideal we seek.

The Disease.—The extent to which goitre prevails is seldom appreciated. In the entire world there are but few countries free from goitre districts, and sporadic cases of goitre exist in every section and in every nationality in the world. In North America, goitre is endemic, that is, especially and continually prevalent, in the whole of the Great Lakes region and in the basin of the St. Lawrence and in the Northwest Pacific region.

The seriousness of the disease itself can be learned with but little investigation. There is an emphasized relation between goitre and cretinism or idiocy, marked by physical deformity and degeneracy. Statistics are not always reliable, but it is safe to say, for instance, that in this region along the Great Lakes, here in Detroit or in Rochester, that seven out of every hundred school children are afflicted with goitre, and further, it is conservative to say, that a large proportion of all the women consulting physicians, have the disease.

Iodine Treatment.—Now, iodine is a natural constituent of the normal

thyroid gland. It is essential to normal thyroid activity. The amount of iodine required is exceedingly small, but when this amount is absent, the thyroid gland seeks by increase in size and surface to make up for this lack in iodine, and goitre is the result. In fact, goitre has been described as an adaptation to "Iodine-deficient" nutrition. It follows therefore that the treatment for goitre now pretty generally practiced is the giving of very small dosages of iodine. An accredited prescription is: 1/10,000 of a gram of iodine taken daily over a period of 15 or 20 days. This given twice a year, once in the spring and repeated again in the fall.

A recent study from the laboratory of the University of Minnesota, by Dr. J. F. McClendon, shows very clearly the inverse ratio between the amount of iodine in surface water and the distribution of goitre. In the neighborhood of the sea, the air and water contain very much more iodine than in inland places, and these places distant from the sea, have the goitres.

Now, what we propose to do is really very simple, namely, to introduce into our drinking water a very minute quantity of iodine and thus bring to the human system and the thyroid gland, that which it needs, and otherwise lacks, to function properly.

This idea of dosing every one willy-nilly is startling, but not unknown, so that it is not altogether revolutionary. For instance, in Switzerland, where goitre is very prevalent, it was decided last February in one canton, to incorporate a small amount of iodine in all the table salt used. All civilized persons take daily, a certain quantity of salt, and as it is inexpensive, and the Swiss Government can control this article of food, it seemed to be the proper carrier for the iodine. This way of doing it—even if it were possible in this country, does not seem to contain, however, the advantages that does the water supply method.

The Rochester Plan.—In the recommendation of our plan in Rochester, Dr. Goler, the Health Officer, makes, among other, the following points:

"1—We always have in Rochester, among our children, more than 2,000 cases of preventable goitre.

"2—We have so much simple goitre because of the absence of minute quantities of iodine in our food and drink.

"3—We may prevent this goitre by the addition of minute quantities of iodine to the drinking water 2/10,000 of a gram to a gallon, in the form of iodide of soda.

"4—Iodine seems to be required by the body and it is when taken into the body in these minute quantities—fixed by the thyroid gland and so prevents its enlargement, and consequent goitre.

"5—If we put iodine in the water, it will only be necessary to dose the water twice a year, for two weeks. This would require daily 13.3 lbs. of Iodide of Soda for two weeks, or 372 lbs. at $4.80 per lb., or $1,785 a year.

"6—Goitres of course, we only get after they have developed. We should like to prevent them. To prevent these goitres would cost less than $2,000 a year. The addition of this minute quantity of iodine would also affect favorably, young persons already having goitres. It would not affect that form of goitre known as 'Graves Disease' or exophalmic goitre. It would not affect the older goitres."

The water bureau has already started this treatment of the water. At one of our reservoirs, from which is drawn all of the water entering the city mains, we have dissolved daily—for a period of two weeks—16 lbs. of Iodide of Soda, a slightly greater amount than first suggested.

Our consumption of water during this period was approximately 25 million gallons per day. In the laboratory of the Health Bureau and checked up by chemists in the University of Rochester laboratory, close track was kept, and it was found that the Iodine content in the water increased from one part in a billion parts of water before the experiment, to twenty parts in a billion. Next fall the dose will probably be increased, as it is planned to get about 50 parts of iodine to one billion parts of water.

Such a water, prevailing for two or three weeks, twice a year, will it is calculated, give to those drinking of it freely, approximately the necessary addition of iodine needed to close the story of simple goitre in Rochester and perhaps from this point, its extinction even throughout the world will begin—Who knows?

Water Works and Sewer Contracts Awarded During the Last 41 Months

The accompanying tables show: First, that the waterworks and sewer contracts awarded during the last half of each year exceed in volume those awarded during the first half; second, that there is not a month in the year without a very large volume of waterworks and sewer contracts; third, that each year shows a gain over its predecessor in the volume of contracts awarded in this "hydraulic field."

The volume of irrigation and drainage contracts will surprise any one who has not followed closely statistics of this sort.

WATERWORKS CONTRACTS EXCEEDING $25,000 IN SIZE.

	1920	1921	1922	1923
January	$ 1,144,000	$ 519,000	$ 1,727,000	$ 4,720,000
February	2,172,000	2,927,000	652,000	2,730,000
March	2,213,000	2,028,000	1,093,000	15,149,000
April	2,719,000	3,342,000	2,673,000	8,544,000
May	1,382,000	4,944,000	3,568,000	7,329,000
June	1,461,000	3,485,000	5,124,000	.....
July	3,793,000	3,106,000	811,000	.....
August	775,000	2,404,000	4,494,000	.....
September	743,000	1,487,000	3,906,000	.....
October	11,169,000	900,000	7,686,000	.....
November	2,151,000	4,698,000	2,161,000	.....
December	1,051,000	10,752,000	1,835,000	.....
Total	$30,773,000	$40,602,000	$35,730,000	.....

Note.—About 100 per cent must be added to the annual totals to give the grand total of contracts awarded in the United States.

A great deal of waterworks construction is done by directly hired labor and is not included above.

Waterworks buildings are not included above.

SEWER CONTRACTS EXCEEDING $25,000 IN SIZE.

	1920	1921	1922	1923
January	$ 1,364,000	$ 3,147,000	$ 2,267,000	$ 3,322,000
February	623,000	2,445,000	2,462,000	2,131,000
March	1,283,000	2,862,000	3,796,000	4,477,000
April	4,124,000	3,817,000	2,794,000	5,497,000
May	2,315,000	2,162,000	5,722,000	9,052,000
June	2,349,000	3,802,000	5,158,000	.....
July	3,163,000	3,986,000	1,869,000	.....
August	2,437,000	3,988,000	3,450,000	.....
September	2,319,000	5,064,000	3,340,000	.....
October	8,052,000	2,829,000	4,996,000	.....
November	4,572,000	2,733,000	5,349,000	.....
December	2,967,000	2,549,000	2,381,000	.....
Total	$36,068,000	$39,384,000	$43,584,000	.....

Note.—About 100 per cent must be added to the annual totals to give the grand total of contracts awarded in the United States.

A considerable amount of sewer construction is done by directly hired labor, which is not included in the above totals.

IRRIGATION, DRAINAGE AND EXCAVATION CONTRACTS EXCEEDING $25,000.

	1920	1921	1922	1923
January	$ 1,542,000	$ 1,266,000	$ 2,091,000	$ 548,000
February	787,000	306,000	419,000	365,000
March	3,151,000	1,626,000	608,000	28,993,000
April	416,000	580,000	1,736,000	2,506,000
May	404,000	2,632,000	776,000	3,553,000
June	605,000	1,240,000	2,628,000	.....
July	1,942,000	609,000	1,498,000	.....
August	4,179,000	89,000	6,920,000	.....
September	859,000	9,025,000	876,000	.....
October	1,086,000	373,000	2,390,000	.....
November	772,000	726,000	1,741,000	.....
December	477,000	707,000	864,000	.....
Total	$16,220,000	$19,179,000	$22,547,000	.....

Note.—About 100 per cent must be added to the annual totals to give the grand total of contracts awarded in the United States.

Design of Water Works Pumping Stations

General Principles and Examples of Recent Construction Cited in Paper Presented May 25 at Annual Convention of American Water Works Association

By CHARLES B. BURDICK,
Of Alvord, Burdick & Hawson, Consulting Engineers, Chicago, Ill.

The average water works involves an investment not less than $35 per capita or say $3,500,000 in a city of 100,000 people. Of this large investment often not more than 25 or 10 per cent represents structures visible to the eye of the ordinary citizen. To the casual observer water works buildings present the only visible evidence of the excellence of the plant, except the water delivered, and his impression as to the property is likely to be based upon what he can see.

Water Works Station Should Be Attractive.—Fundamentally there is no reason why the water works station should not present the same attractive appearance as the city hall or any other municipal building. It should be permanent, clean, and as easily kept clean as a modern hospital, for it handles a commodity used in every home. An ornate design justified in a city hall or a courthouse would be out of place in a pumping station. Rather it should represent the masculine in architecture without undue pretention, strong and permanent in its lines and materials, frankly adapted to its purpose, and presenting an appearance agreeable to the eye. This will require compliance with laws of good architecture. Appearance must not be neglected in structures likely to live a long time.

Providing for Expansion.—Water works construction is now sufficiently standardized so that it is possible to lay out pumping plants subject to enlargement in such manner that the buildings may be useful indefinitely. The pumping and power equipment should be arranged with the idea of expansion. It is usually practicable to build only for a moderate time in the future, but it costs little to lay down the indefinite future additions on paper, and so to locate the building, and so to arrange the equipment that extensions may be made without destroying the usefulness of important parts of the plant.

It is all too common to find layouts that have expanded piecemeal according to the path of least expense, which must be torn out and rebuilt, because further expansion is impracticable. We can see farther into the future today than was possible a generation ago. There may be radical improvements in water works equipment hereafter, but if the general plan of expansion has sufficient elasticity, the probable future can be accommodated.

The Heart of the Plant.—In the ordinary water works plant, steam operated, there is, first, the heart of the plant, so to speak, consisting of the main entrance, offices, and possibly a laboratory which may be grouped, and will need little further expansion. The engine room and the boiler room after providing for the present and the immediate future may be expanded along parallel lines without necessarily spoiling the architectural symmetry. It is wise to be liberal in selecting dimensions. This tends toward permanency.

If the water is filtered, it is desirable in small pumping stations to centralize the "business end" of all the station operations on account of facility in supervision. This complicates the design, especially the provision for future expansion, and centralization is not always possible when filtration is added to an old water works.

In the layout of a new plant, however, it is practicable so to co-ordinate the expansion of pump room, boiler room, filter plant, coagulation basin, and clear well, that each may be enlarged in an orderly manner with convenience of access between the operating parts and the administrative center of the group. Basins and reservoirs may expand, if necessary, forward from the building, utilizing a space covered over by lawn.

Plants in cities up to 100,000 population, or somewhat more, may thus be designed without the necessity for separating the pumping and filtration plants. A compact arrangement is quite necessary for economical operation in a small city where it may be desirable to operate filters without adding to the number of employes.

Fireproof Construction.—The mod-

ern water works station is fireproof throughout for obvious reasons. Permanency requires it. It should be the last building to burn in any community. Many water works stations are practically fireproof except for the roof construction, windows and the doors. It is practicable to build stations today without using a stick of wood, and at moderate costs as compared to wood. Millwork has increased in price to such extent that there is little difference between wood and metal frames, and concrete and tile construction is generally used for for roofs in the most modern stations.

Construction Materials.—For underground structures or for other structures, more or less concealed and protected from the weather, concrete gives excellent service. Where exposed to view or subjected to the action of the elements, it is not proving a satisfactory building material. Wherever possible it is wise so to design reservoirs that they may be filled over and sodded, thus protecting the concrete from the expansion and contraction of hot sun and winter cold, and incidentally better protecting the water from extremes of temperature.

For superstructures, brick and stone are the most satisfactory materials for exteriors; terra cotta may be useful upon the interior or exterior. Upon the interior the surface should be clean and non-absorbent. Concrete floors are satisfactory only in the cheaper structures where they may be successfully used if covered with a heavy non-absorbent paint especially adapted to concrete. In the better stations terrazzo or tile is justified.

Walls, particularly where damp, as in the pumping pits, should be faced with a non-absorbent substance such as enamel brick built at least head high. Above this plane pressed brick is satisfactory. At present a rock plaster is available almost as hard as stone which con be worked into very attractive panel designs at moderate cost.

Pumping Station of Des Moines, Ia., Water Works.

The Roofs.—For the roof, exposed steel trusses are generally used with steel purlins and a roof covering of reinforced concrete or tile. In order to prevent sweating in cold weather a double ceiling is desirable. This may be accomplished by rock plaster

on metal lath hung from the purlins. Thin concrete roofs usually become a nuisance at certain times from dripping. A single thickness of 5 ins. is usually sufficient to prevent the serious collection of drops. A double ceiling completely eliminates the trouble and costs comparatively little more. Skylights and ventilators must be guarded with gutters for satisfactory results.

It is proposed to cite a few examples of recent pumping station construction with figures of cost. Practically all of this work has been done in co-operation with Mr. Victor A. Matteson, architect, Chicago.

Des Moines Pumping Station.—The new 21st street pumping station at Des Moines is a steam station. It pumps the entire water supply of the city in one operation from the ground water collecting galleries into the pipe system against direct pressure. The rates of pumpage at the present time are as follows:

Minimum night rate M. G. D...	6.5
Average Day M. G. D.....	10.0
Momentary peak.....	18.0
Maximum fire demand.....	24.0

The pumping plant consists of three DeLaval turbo-centrifugal geared units, two of 15, and one 25 million gallons capacity. These pumps operate at 269 ft. total head with 200 lbs. boiler pressure and 100° superheat. The two smaller of these pumps developed duties on test ranging from 150 to 114 million foot pounds per 1,000 lb. of steam at full capacity and half capacity respectively. The larger pump is guaranteed to deliver 161 million duty at full capacity, 164 at three-fourths capacity and 144 at one-half capacity.

Boiler Plant at Des Moines.—The boiler plant consists of four 323 H. P. Springfield water tube boilers. One boiler is served by a LaClede-Christy natural draft chain grate stoker. Three boilers are equipped with Harrington chain grate stokers operating on natural draft up to 125 percent rating, and forced draft up to 200 percent rating. The plant burns a low grade of bituminous screenings (Poke County, Iowa), ranging from 8,000 to 10,000 B. T. U. The individual boilers and stokers in this plant developed on test from 72 to 74 percent efficiency when operating on natural draft slightly above boiler rating, and 70 percent on forced draft at slightly under 200 percent rating.

This boiler and pumping plant serves the city on about half the tonnage of fuel per unit of water pumped required by the old pumping station, served by hand-fired tubular boilers and compound crank and flywheel pumps. The greater part of the saving is secured by the improved boiler plant.

Coal Handling.—The matter of handling coal is a difficult one in a water works boiler plant by reason of the magnitude of the peak load as compared to the comparatively small average load. Coal handling equipment of the type adapted to electric lighting practice often fails to show economy when applied to the small tonnage burned by water works, on account of fixed charges. The device adopted at Des Moines consists of a gantry crane feeding from cars or coal pocket to an overhead bin in the boiler room. It also picks up ashes dumped to the ash pocket by hand, loading the same into cars or trucks. By the use of this crane one man unloads all cars not dumped, and handles all coal and all ashes for a 24 hour shift in three hours or less. The coal handling scheme at Des Moines at the present price of labor a little more than "breaks even" with hand coal handling labor, fixed charges considered. Its installation was considered warranted in view of the probable future increased cost of labor.

Building Group at Des Moines.—The group of buildings comprising the new water works pumping station at Des Moines consists of the main pumping station and boiler room, a shop and garage building for the accommodation of all automobiles and trucks used by the Water Department, a warehouse, with pipe yard adjoining, for storing pipe, fittings and miscellaneous supplies; also a group of cottages housing four families of water works employes.

The main pumping station consists of a pump room containing space for eighty million gallons in pumping capacity. Fifty-five million gallons capacity is at present installed. The boiler room contains 1,300 H. P. in boilers and space is provided for enlargement that may be required after 1940.

Adjoining the main entrance to the pumping station are located an office for the chief engineer, a laboratory, and toilet accommodations for the

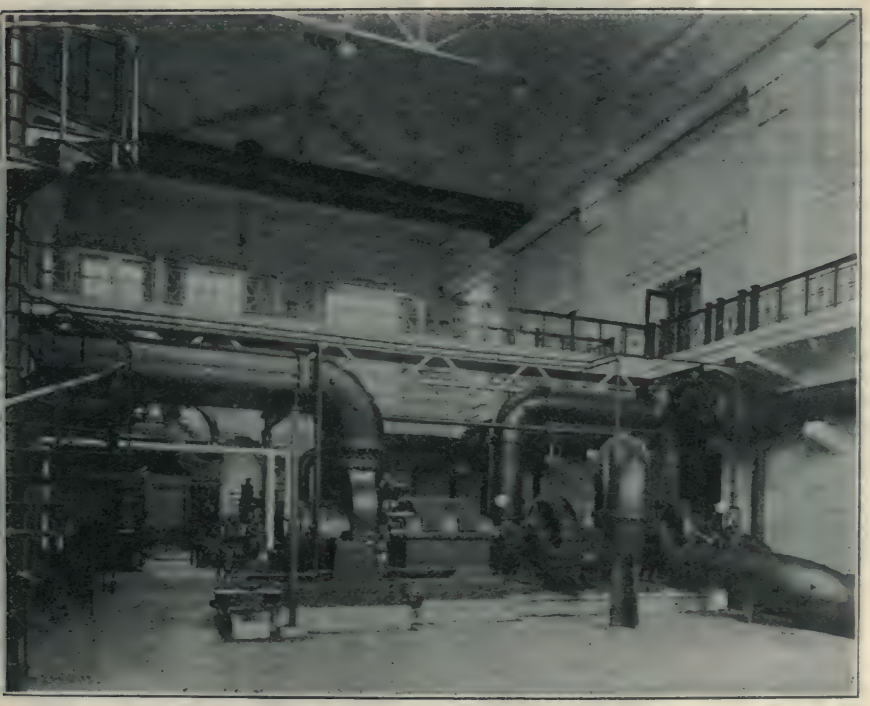
public. Employes' toilet rooms are located between the pump room and boiler room. Galleries are provided in the pump room for the accommodation of visitors, so that the pump room may be seen without interfering with the operation of machinery.

All foundations are constructed of heavy reinforced concrete. The pumps are set 13 ft. below the high water line, thus necessitating a heavy pump pit floor and walls to resist upward and inward pressure. The pumps are thus located in order to draw from the gallery system in extreme low water.

The pump room is finished with terrazzo floors and white enamel brick walls up to the top of the wainscot at grade line. Above this point the walls are paneled and coated with rock plaster. The roof is supported by steel trusses carrying Federal cement tile with a composition roof covering. Steel windows, doors and trim are used throughout.

The boiler room is finished with concrete floors, with walls of common brick painted. The entry way and halls are floored with terrazzo, and provided with terra cotta walls. The exterior of the building is of dark red tapestry brick with Bedford stone trim.

The shop and garage building exterior finish is similar to pump house. The interior is finished with concrete floors and common brick walls, and the whole is surmounted by a timber mill construction roof, slow burning type, and covered with composition roofing. Steel window sash are used. The remaining millwork is of wood.



Pump Room of Station at Water Works of Des Moines, Ia.

This building provides all facilities for the maintenance of the water works motive power and contains a wood shop, machine shop, paint shop and in the rear a stable for the accommodation of one team.

The warehouse building resembles a small freight house in general plan with an office space in the front where all water works labor is handled and assigned to its daily tasks. A siding runs parallel with the warehouse with platforms on both sides, so that freight unloaded may be wheeled through the storeroom and loaded on

wagons or trucks. Heavy freight such as pipe and large fittings may be unloaded from the opposite side of the cars and stored in the pipe yard. This building is surmounted by a mill construction wood roof. Floors are of concrete and the office walls are plastered. Wood millwork is used throughout this building.

Three wood and stucco English cottages provide for four families. One cottage contains five rooms, one cottage six, and one double cottage contains two six-room apartments. Each apartment is provided with concrete cellar, furnace heat, plumbing, maple floors, plastered exteriors and shingle roofs. These apartments are rented to employes at cost. The rent charged is $30 per month per apartment exclusive of heating and light.

Water Works and Light Plant at Orlando, Fla.—At Orlando, Fla., the new station is now nearing completion. This accommodates the water filtration plant of four million gallons capacity, electrically driven centrifugal pumps of 12 million capacity augmented by four million of steam pumping capacity in another station. The generator room contains 4,000 K. W. in turbo-generators with space for 2,500 additional K. W. The boiler room contains 1,500 H. P. in boilers, oil fired.

The Spanish type of architecture was used, as especially adapted to a warm climate. The boiler room is open on the rear, the boiler fronts being protected by open archways. The walls are of brick with exterior cement plaster. Roofs are supported on steel trusses with concrete slabs and composition surface. Red tile is used for sloping roofs and wall caps. The interior of the pump room is plastered. All other wall surfaces are of common brick painted. Floors are of red quarry tile.

Table I shows the cost of the Orlando building, including filter house and concrete filter beds; also clear reservoir underneath the filters, but does not include cost of filter equipment or any other equipment of the plant except as stated in the tabulation.

Manistique, Mich., Tower.—The opportunity was afforded at Manistique, Mich., to combine a small electric driven pumping station and a water tower. The water supply at Manistique is delivered by gravity, substantially at ground height, to the center of the town, where it is pumped electrically into a steel elevated tank surmounting the pump house.

The land occupied by the pumping station was donated by a public spirited citizen upon condition that an attractive station and tower should be built. Manistique is a small city with a population about 7,000. A plan was worked out which accommodated the necessary electrically driven pumps in the base of the tower, and the saving thus effected permitted enclosing the tower in an attractive envelope. The cost of the structure thus built is approximately equivalent to an uncovered steel elevated tank plus a separate building of fireproof construction.

Table I—Cost of Pumping Station Buildings

	Cost	Contract Date	Cu. ft. —(Thousands)	Cost per cu. ft.	*Cost Price Base	*Present Price Base (Mar., 1923)	**Present Cost per cu. ft.
PUMPING STATIONS—							
Des Moines, Iowa	$220,479	1920-23	810	27.0c	178	198	30.0c
Ashland, Ky.	34,194	Oct., 1921	130	26.4	159	198	32.8
Orlando, Fla.	91,800	Sept., 1922	510	18.0	180	198	19.8
Ironwood, Mich.							
Main Station	29,155	July, 1920	65	44.8	269	198	33.0
Sub Stations	9,644	July, 1920	7.5	64.2	269	198	47.6
Manistique, Mich.	71,379	Sept., 1921	140	51.0	156	198	65.0
La Crosse, Wis.	50,834	Nov., 1912	484	10.5	100	198	20.8
Prairie du Chien, Wis.	21,017	Sept., 1921	77.8	27.0	156	198	34.3
AUXILIARY BUILDINGS—							
Des Moines Garage	51,027	May, 1922	390	13.1	160	198	16.2
Des Moines Warehouse	18,754	May, 1922	111	16.8	160	198	21.0
Des Moines Cottages							
3 Cottages, 4 Fam. 22 Rooms	20,430	May, 1922	18	29.2	160	198	36.0
Ironwood Cottages							
2 Cottages, 2 Fam. 12 Rooms	16,900	July, 1920	16	44.5	269	198	33.0

*Building materials U. S. Dept. of Labor.

—Each building where more than one—Contents based on outside measurements footing to average roof.

**As of Date April 1, 1923.

The steel tank contains 200,000 gal. The top is located 107 ft. above the ground. It has a hemispherical bottom and is supported on the brick work 64 ft. above ground by means of eight short legs horizontally braced. The tower is constructed of brick with red tapestry face brick. The trimming on the lower portion of the tower is Bedford stone and the cornice is constructed of reinforced concrete cast in place. The dome is of zinc supported on wood trusses.

The tower is octagonal outside and 16-sided inside. The brick cross-section is sufficient to support the superimposed load with a unit pressure not exceeding 175 lb. per square inch.

The 16-sided pump room is 33 ft. in inscribed diameter. It is floored with terrazzo with white enamel brick wainscot, and rock plaster walls and ceiling. A false roof is provided over the pump room with drains to catch any drip or leakage from the elevated tank. A cellar under the pump room accommodates all pipes, heating and plumbing equipment.

The electric pumps are pressure controlled from the tank and start and stop automatically. No attendant is required in the operation of the plant except for periodical visits for inspection and oiling.

Gary, Ind., Station and Water Tower.—The Gary pumping station and water tower, although built a number of years ago, is an example of what is possible in the use of concrete.

The water tower is simply a housing for a steel elevated tank supported on vertical steel legs entirely independent from the envelope. This plan was followed on account of the necessity for haste in providing a water supply for the city during the building period. The concrete envelope was added later. The shaft of the tower is of reinforced concrete with a concrete dome roof. The base of all cornices and the facing on the lower one-fifth of the tower is of precast concrete applied in the usual manner where stone is used. The shaft proper is of reinforced concrete with a reinforced concrete dome roof.

Water Works Station and Filter Plant of Ashland, Ky.

The pumping station has concrete foundations. The pump room is depressed below the ground level and is lined with white enamel brick. Above grade walls are of brick with buff pressed brick interior face, and precast concrete exterior face. The exterior face blocks are of two colors, gray and dull red.

Ashland, Ky., Installation.—The Ashland, Ky., plant exemplifies construction for a small city. It includes an electric driven pumping station

with gasoline reserve pump; also a water filtration plant. Construction throughout is entirely fireproof and of good appearance, but no extra money was spent for the sake of appearance.

The entrance to the plant is through the operating floor of the filtration plant. The filter beds produce a terrace effect.

Upon the Ohio river the intake problem is important on account of the extreme variation between high water and low water. The low lift pumps are located in a pit 26 ft. in diameter and 43 ft. deep. They consist of two motor driven centrifugals and one high speed gas engine centrifugal, each 2½ M. G. D. against 65 ft. head. Three pumps of the same kind of capacity operate against 275 ft. head when pumping to the city. These pumps and the filters are installed on the roof of the clear well.

The filtration plant consists of four beds, total capacity 2 2-3 M. G. D. High velocity of wash is used from a 35,000-gal. steel wash tank set on the roof of the pump pit.

Ironwood, Mich., Plant.—This plant develops a ground water supply from driven wells and pumps it against a head of 650 ft. through a four-mile pipe line of 16 ins. diameter. The water is developed from three shallow well groups, each sub-station containing a 2 M. G. D. pump. The main pumping station contains two three million gallon electric driven centrifugals and one and one-half million gallon high speed gas engine driven centrifugal. One gasoline driven centrifugal is also installed for reserve low lift pumping.

The buildings connected with the Ironwood water works are all constructed from boulders picked up on the water works lot. The saving thus effected as compared to brick was nominal, but it is believed that these buildings present better appearance than would brick structures in the locality where built.

The main pump house has walls of boulder stone plastered inside on metal lath and painted, floors of concrete painted, and the roof is slate on wood with matched and beaded ceiling oiled, and exposing steel trusses. Three similar sub-pumping stations were built and as the plant is located some distance from habitation, it was necessary to construct two six-room dwellings also built of boulder stone.

Prairie Du Chien, Wis., Plant.—This plant represents the practicabilities in a small town where the funds available for water works construction were quite limited. This pumping plant consists of a concrete pit 45 ft. inside diameter by 24 ft. deep surmounted by a mill construction wooden roof with a small brick building attached to the pit at the ground level for office and shop purposes.

This plant is electrically operated. Water is sucked directly from four driven wells immediately outside the pit wall and discharged into the pipe system which is connected to an elevated reservoir on the adjoining bluffs. The pumping installation consists of one motor driven centrifugal 500 G. M., 340 ft. head, one 600 G. M. high speed gasoline engine centrifugal, and one 600 G. M. motor driven triplex pump moved from an old pumping station. Space is provided for a fourth pump at some time in the future.

All foundations are of reinforced concrete. The superstructure and the parapet around pumping pit is common brick with moderate priced face brick. All sills, lintels and caps are built of precast concrete. All roofs are of wood construction. The composition roof covering of the pit is concealed by the brick. The roof of the office and shop structure is finished with cement interlocking tile. Concrete floors are used throughout. Interior walls of brick are painted.

Cost of Pumping Stations.—The cost of the pumping stations that have been described and several others are shown in Table I. As the prices of labor and material have fluctuated quite materially during the period in which these stations were built there is shown in the table the date of the contract, the price basis at the time and the price basis at the present time. The table also shows the cubic foot cost of the stations as of the time when let and as of the present time. In computing cubic foot cost the contents of the building have been figured based on outside measurements and taking the height from the footing level to the average outside surface of the roof for each part of the building.

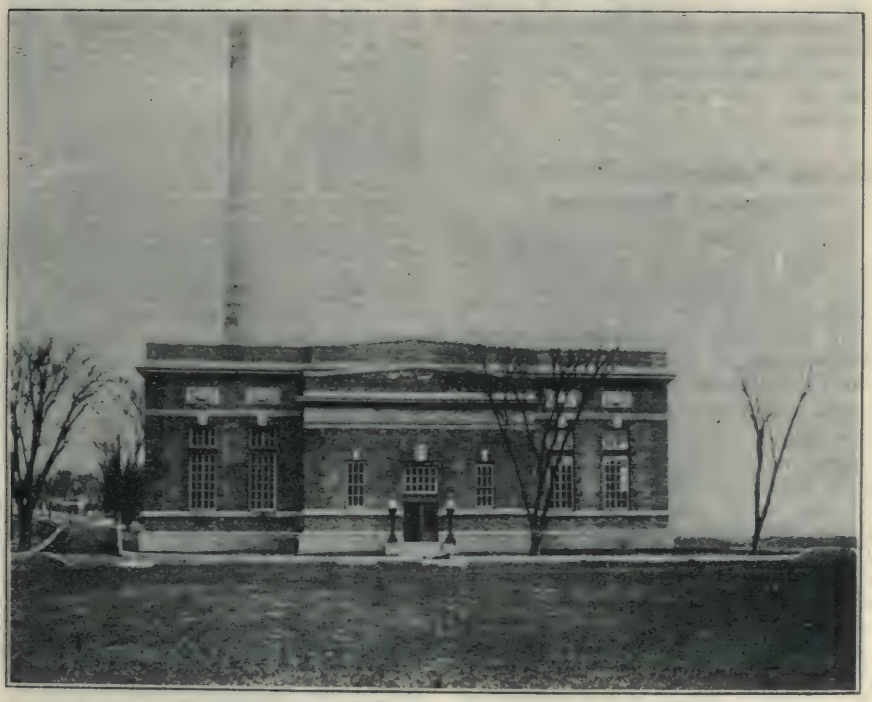
The tabulated price basis is the average cost of building materials as published by the U. S. Department of Labor. This refers to the average prices of 1913 as 100 per cent. The use of this price base presupposes a

fluctuation in labor equal to the fluctuation in material price. The price of labor generally fluctuates less than the price of material. However, it is true that the efficiency of labor enters into contract cost and it is generally true that when materials are high labor is scarce and its efficiency decreases, therefore tending to make labor cost more nearly fluctuate with the prices of materials. Apparently the assumption made regarding labor does not seriously affect the comparisons of cost, for the unit prices appear to line up very well in the comparison of buildings.

Comparison of Costs.—In comparing the costs of buildings there are innumerable factors that might be considered. Pumping stations, however, are generally similar in type and vary principally in dimensions and in the degree of finish. In theory the cost of roofs and floors varies directly as to area and that the cost of walls increases 43 per cent in doubling the area or decreases 14 per cent when the area is cut in half. These proportions hold only for perfect squares, but the difference is small for an ordinary rectangular building. Miscellaneous details such as plumbing and heating are considered to vary directly with cubic contents.

Upon the above basis the cost per cubic foot of an ordinary pumping station is decreased about 14 per cent in doubling its contents and it is increased about 13 per cent when its contents are cut in half.

It has been noted that the cost of box type reinforced concrete reservoirs follows closely the cost of moderate priced buildings.



Pumping Station of Water Works of La Crosse, Wis.

Co-operation With Architect.—It would be well if all engineers would utilize the services of an architect in the planning of conspicuous engineering works. A good architect possesses a knowledge of orderly arrangement, and the selection and grouping of materials, not possessed by most engineers. On many classes of structure the architect should be and is the master builder, and the engineer is properly a subordinate. Upon such special structures as water

works buildings, the engineer must be the master builder, but he is wise if he fully utilizes the services of one skilled in architectural design. This must be done by co-operation; the engineering plans should be worked out together, step by step, as a unit.

The water works manager should not ignore public approval relating to his work and his plant. Self-respect engenders respect from others. Capable operators say that employes take better care of their machinery and are more contented when working in attractive surroundings. A good plant is an important element of good service. The time has come when water works designers can safely plan for the future and build for permanence.

Electric Public-Utility Power Plants Increase Production

A remarkable increase throughout the United States in efficiency in the use of fuel and the production of electricity during the past four years is seen in a statement just issued by the Department of the Interior, through the U. S. Geological Survey.

The statement indicates that electric public-utility power plants produced more electricity in 1922 than ever before, and that over one-third of the total amount produced was generated at water-power plants, thereby conserving over 20,000,000 tons of coal in 1922. New York is the leading state in the production of electricity by public-utility power plants and California is the leading State in the production of electricity by the use of water power. One-fifth of the total amount of electricity produced by water power in the United States is produced by California hydroelectric power plants.

Reports on the monthly production of electricity and consumption of fuel by electric public-utility power plants in the United States are now being published by the Geological Survey.

A summary of the monthly reports has been prepared and is now available for general distribution, and can be obtained on application to the Director of the Geological Survey, Washington, D. C.

Rapid Sand Filtration Plant Operation

Process Described in Non-technical Manner in Paper Presented May 19 Before Canadian Section of American Water Works Association

By WILLIAM D. HATFIELD
Superintendent of Filtration, Highland, Park, Mich.

In presenting a non-technical paper which would be interesting to the water works superintendent, who is interested in water purification but not a chemist, I have tried to avoid all unnecessary technical terms which are familiar only to the specialized chemist or sanitary engineer, though in so doing I will lose much of the accuracies of technical terminology.

General Layout of Plant.—First I will describe the general layout of a rapid sand filtration plant and the steps in the purification. Naturally the first step is to get the raw water to the plant. In some places it is possible to run the raw water to the plant by gravity, but usually it is pumped into the chemical mixing chamber by low service pumps. In some places where the water is heavily laden with silt, it is first settled in a reservoir to remove this heavier material before the water goes to the mixing chamber. As the raw water enters the mixing chamber, a solution of the correct amount of aluminum sulphate is usually added and mixed with the raw water by passing around, over and under baffle walls. In some cases iron sulphate and lime are used instead of aluminum sulphate. This mixing process usually lasts from 15 to 45 minutes, and in that time the chemical has got a good start toward bringing the dirt and bacteria together in groups. After leaving the mixing chamber the water flows slowly through the coagulation or sedimentation basin in which the groups grow in size and about 75 per cent of them settle out carrying with them most of the dirt, color and bacteria. The time of sedimentation varies in different plants from two to eight hours.

This coagulated and settled water then passes through the sand filters which remove the remaining amount of added aluminum, turbidity, and practically all the bacteria. The

water in the process of filtration passes down through from 20-30 in. of filter sand and then through from 12-24 in. of graded gravel; the small gravel first and the larger gravel at the bottom. The filtered water is collected in the bottom of the filter in a network of pipes into which are inserted brass strainers with small holes. The filtered water then flows through rate controllers which keep the filters operating at a constant rate of flow within certain limits of allowable flow. This control is necessary or the clean, freshly washed filter will allow the water to pass too fast for efficient filtration. From the rate controllers the filtered water passes to the filtered water reservoir usually called the clear well.

In a properly designed and operated plant, this filtered water should be safe to drink, but we have a very effective "safety valve" in the use of liquid chlorine which sterilizes the few bacteria that may slip by in the filtration process, and the cost of such treatment is so small that we cannot afford to be without the added protection. The chlorine is usually added to the filtered water as it flows to the clear well. However, in some cases it has been found more efficient to add the chlorine either before the alum treatment or just before filtration. The high service pumps are the last step in the filtration plant proper, for after that it is purely a matter of distribution of the tap water.

Chemistry of Treatment With Aluminum Sulphate.—In as non-technical a way as possible, I will try to explain the "How and Why" behind the chemistry of the treatment with aluminium sulphate. As rain drops pass through the air they dissolve, among other gases, carbon dioxide, and as the water runs off of and through the ground, it picks up more of this carbon dioxide which is a product of decomposition of both animal and plant life. This rain water containing the carbon dioxide has a dissolving action on the different forms of lime-stone in the earth. This dissolved lime-stone that exists in natural waters is called by the chemist calcium magnesium bicarbonate, but we will call them the alkaline salts because they make the water alkaline.

When the chemical aluminium sulphate is added to this alkaline water, the aluminium and the alkalinity unite to form sticky white masses in the water. This is called the "floc" by the operator, and aluminium hydroxide by the chemist, and resembles the white of a soft boiled egg. This sticky white material which at first forms in millions of minute particles in the water, sticks to the dirt and bacteria, and as these particles come together, they stick to each other forming larger particles, 75 per cent of which become so heavy that they settle out in the settling basin before the water reaches the filters. The settled water as it goes on the filters carry the remainder of this sticky material which then forms a sticky blanket on the surface of the sand. It is this sticky blanket through which the settled water filters, that removes the last traces of the added aluminium and dirt or turbidity from the water; it also removes practically all the bacteria. Without this sticky blanket on the sand, the turbidity and bacteria removal would be very poor.

From time to time since treatment with aluminium sulphate began we have had agitation regarding aluminium getting through the filters in a soluble form. In all probability if part of it did get through one would have to drink a barrel of water to get a medicinal dose, and it is doubtful if aluminium has any physiological effect on the concentrations used in water purification. However we need not worry about this, for results on plant operation show that within a wide range of treatment, the added aluminium is not only all removed but also some of the naturally dissolved aluminium which was already in the raw water is removed. If the treated water is too acid or too alkaline, the aluminium floc is soluble, but this zone of insolubility between the "too acid" and "too alkaline" points is very broad in many surface waters, and the operator of a plant would be inefficient if any aluminium gets into the filtered water. Some soft waters do not contain enough of the alkaline salts to react with the amount of aluminium necessary to clarify the water. In these cases artificial alkalinity must be added by using lime or soda ash.

Filter Plant Operation.—In the operation of a filter plant, close observation must be kept on the quantity as well as the quality of the raw water used. If the plant is designed

with a relatively small clear well, the only safe method of operation is to keep the clear well full at all times. This necessitates changing the rate of flow of the raw water, and rate of filtration, to parallel that of the high service pumps; it also means a close watch on the alum dosage which must be regulated with each change of raw water rate. It is much more satisfactory and convenient to have a larger clear well so that it can be allowed to drop a few feet during the day and catch up during the night. In such a case the raw water rate and chemical treatment can be kept relatively constant for long periods of the day.

There are two common methods of adding the chemical. The older method is to dissolve a known amount of the alum in a tank of water of known capacity and to run this solution through orifice into the raw water. The newer method is to add the dry ground alum by means of machines which mechanically drop a known quantity of the chemical in running water which dissolves it and carries it to the mixing chamber. The machines may be checked for delivery by holding a container under the machine and weighing the ounces of chemical delivered per minute. This method is much more accurate and satisfactory than the former method. The amount of alum necessary to coagulate a raw water must be determined by an experienced man. This amount is dependent on the alkalinity, turbidity, bacterial pollution, and the much talked of hydrogenion concentration. The chemical feed should be checked up hourly in any plant.

As the floc blanket builds up on the filters, it gradually clogs the sand surface and decreases the pressure of the water flowing through the beds. This decrease in pressure is called loss of head, and will continually decrease while the filter is in operation. When the loss of head has reached a certain predetermined point which varies from 4 to 12 ft. on different filters, they must be washed. Washing the filters when the loss of head reaches a certain point is the usual method, but recently some operators have been running the filters until a very slight turbidity comes through regardless of the loss of head. The amount of wash water will vary from day to day, but will usually average from 0.5 to 3.0 per cent of the total water filtered.

The hours of service which a filter runs before it must be washed is an important item because it shows the efficiency of the chemical treatment and of the sedimentation. A plant should always run so that the coagulation and sedimentation does most of the work and the filters only finish up the job. Hourly records should be kept of the filter operation.

Chlorination.—In most cases the filtration process as a whole should always be operated so that the filtered water is satisfactory for drinking purposes, but even where this is possible the filtered water should be chlorinated with a minimum amount of chlorine to sterilize any bacteria which might slip through the process under some extraordinary condition. This chlorination is our safety valve and a very valuable one, but like a safety valve it should be there only for the unusual occasions and should not be relied on to do the work of the filtration process.

It is easily seen that water treatment is a chemical process and that laboratory control would be essential to efficient operation. It is too bad that in so many cases cities will build expensive plants and then fail to economize by running the plant without the trained supervision of a chemist or a sanitary engineer that thoroughly understands the chemical side of operation. Laboratory control tells us the quality of the raw water, the efficiency of coagulation, sedimentation, filtration and chlorination. The number and kind of chemical and bacteriological determinations necessary at different plants will vary greatly. With one water certain tests will be absolutely necessary while with another others will be of more value. For example, I have never heard of a plant where the determination of dissolved oxygen or air in the water was of any value until I took charge of the Highland Park plant. At certain times of the year, this is the most important test we make for the efficient operation of the plant.

Sewer Trenching With Dragline Excavator

A combined sanitary and storm water sewer system is now being constructed by Booth & Flinn, Ltd., in 25th St., North Beach, for the Borough of Queens, City of New York. This work is part of the modern sewage disposal project recently adopted by the City of New York as a necessary step in the development of this borough. The section now under construction consists of a concrete cut-off chamber, junction chamber, overflow chamber, and screen chamber, the latter equipped with two 14-ft. Rinsh Wurl revolving screens; together with 1250 ft. of reinforced concrete storm water sewer, 14 ft. 7 in. x 8 ft.; and 1100 ft. of reinforced concrete sanitary sewer, 9 ft. x 9 ft.

The two sewers are located side by side and are being constructed in a single trench, excavated by the open cut method. The design provides a space of 3 ft. 8 in. between the two sewers so that, with sheeting and bracing, the trench is 35 ft. wide. The maximum depth is 38 ft., with an average depth of about 26 ft., and the material excavated is sandy clay on top with fine hard sand below, with the trench bottom from 5 to 7 ft. below high water.

This work is located in an undeveloped section, 25th St. being a proposed thoroughfare at this point, with ample room for casting the excavation on the trench bank. With this condition in mind, the contractors have adopted a method of excavation that is seldom practiced in this section of the country, especially within the City of New York on sewer trenches, that of the dragline excavator. For this purpose an Osgood ¾-yd. heavy duty dragline is being used, operated by steam power and equipped with a 45-ft. boom and a ¾-yd. Page dragline bucket. This dragline is fitted with continuous tread traction and rides on top of the cut and within the lines of excavation, somewhat to one side, and in operation drags the excavation in a circular fashion, with and across the

Dragline Excavating in 25th St., Queens Borough, New York City, for Sanitary and Storm Sewers

cut. The material is loaded into motor trucks without any spilling and between trucks is cast on the bank, well back from the cut. The excavation is cast only on one bank, the opposite one being kept clear for passage of a traveling derrick for use in excavating the trench bottom.

The dragline excavation is 40 ft. wide at the top, 35 ft. wide at the bottom, and digs from 13 to 21 ft. deep, depending on the stiffness of the soil, as the trench is not sheeted until after the dragline excavation has been made. This dragline has also been used in excavating, with a drag bucket, for the bottom in the sheeted sections, in sand and water, working between the bracing. The average progress has been about 350 yds., in place, for an 8-hour day.

The two sewers are being concreted by means of Blaw-Knox steel forms, with a traveling mixer plant located on top of the trench, while the backfill is placed from the cast spoil on the opposite bank.

This work is under the direction of Frank Perrine, Engineer of Sewers for the Borough of Queens, and Mr. M. L. Quinn, General Superintendent for Booth & Flinn, Ltd., and Mr. William Griff, Resident Superintendent.

Water Power Investigations to Be Made By the Interior Department

During the field season of 1923 extensive river surveys will be made by engineers of the Department of the Interior, Geological Survey, to determine the possibility of developing power on streams in practically all the public-land states. These surveys will be made by plane-table methods and will include a plan and profile of the river and contours to a height of 200 ft. or more above the water surface. Where the conditions are favorable to the construction of dams or reservoirs, special surveys will be made for mapping on a relatively large scale. Hydraulic engineers will select the dam sites and geologists will examine and report upon the geologic features of those that appear to be the most favorable.

These surveys and the records of stream flow collected by the Geological Survey form the basis for the classification of public lands with reference to their value as power sites. Most of the maps made will be published and will be available for purchase at moderate prices. Many of the reports prepared as a result of such surveys are published as water-supply papers or are kept open for public inspection at the district offices of the Geological Survey as well as at Washington, D. C. A complete inventory of the water-power resources of the public-land States is thus being prepared. The program for 1923 includes the following work:

In Oregon 300 miles of Rogue River and tributaries will be mapped and surveys of dam sites will be made.

In northern California and Oregon, the survey of Klamath River from Keno, Ore., to its mouth will be completed. This work will involve 100 miles of additional surveys.

In Utah, surveys covering 100 miles will be made on East or Yellowstone Fork of Lake Creek, West Fork of Lake Creek, Rock Creek, Duchesne River, and Uinta River.

In Idaho, surveys of a dam and reservoir site will be made on Salmon River.

In Montana, a dam site on the South Fork of Flathead River will be surveyed and a reconnaissance will be made to determine the possibility of using Missouri River and its tributaries above Great Falls, Mont., for power purposes.

In Colorado, surveys will be made on South Boulder River, Clear Creek, Chicago Creek, St. Vrain Creek, Left Hand Creek, Big Thompson River, North St. Vrain Creek, South St. Vrain Creek, and Middle Boulder River, all tributaries of South Platte River.

In Wyoming, surveys will be made on Sweetwater, North Platte, and Encampment rivers.

In Arizona and Nevada, 300 miles of Colorado River will be mapped.

In Washington, investigations of the Columbia Basin irrigation project are now being made.

Public lands reserved for use in connection with power sites and shown by these surveys to be without power value will be recommended for restoration to entry. Lands that may be used in connection with power sites but that are well adapted to other uses will be recommended for restoration to entry with a reservation of the right of the United States or its permittees to use them as power sites. Public lands that are found to be valuable as power sites and that are not already reserved will be classified as power-site lands and withdrawn from entry.

British Developments in Activated Sludge Process

Recent Work Reviewed in The Surveyor, London

By H. C. H. SHENTON

Bulking of Sludge at Manchester.—In the report of the City of Manchester Rivers Department, dated March 31st, 1921, the following important statement is made:—"Reference has been made previously to the occasional difficulty which has been experienced in the efficient settlement of the sludge, due, apparently, to sudden alteration in the physical character of the sludge, which at frequent intervals has shown a tendency to increase in bulk to an abnormal extent. Attention has been paid to this problem during the last year, and observations made under working conditions, together with periodic microscopic examination of samples of sludge, tend to confirm the previously expressed opinion that this abnormal condition of sludge is due primarily to low air supply. It would appear that a low air supply over a prolonged period brings about conditions, probably arising from the incomplete activation of fresh sewage solids, favourable to the growth of the higher organism." It is important to note that bulking has only been experienced in the diffused air method when the air has been reduced in volume; on the other hand, it has been shown in Fairbrother and Renshaw's paper, read before the Royal Society of Arts, that at the time of bulking protozoa are exceptionally numerous, and it is suggested that they may interfere with normal purification, and it was further ascertained that by adding a chemical that had a slight bactericidal action, but a powerful lethal action on protozoa, that the trouble was removed. The paper has been referred to already in The Surveyor, and it is unnecessary to give further details. This use of disinfectant ought to be particularly useful in cases where the aeration cannot be easily increased to deal with the trouble. It appears that this difficulty will arise, and that the process will be more useful in the case of mechanical agitation than in the case of the diffused air method.

Irrigation With Sludge Effluent.—In a recent letter from Professor Fowler, which the author is at liberty to quote, referring to Jamshedpur, in India, he says that he was "delighted to see the really marvellous results of irrigation of practically desert land, with the effluent from the activated sludge installation containing activated sludge in suspension. There are 40 acres of all kinds of garden stuff, as well as large crops of sugarcanes nearly 15 ft. high, and there was no nuisance of any sort. I have seldom felt so gratified with an experiment; there are nearly 1,000 acres available for further extension of the farm as soon as finances permit. The plant itself was working all right, especially as it was taking about 50 per cent more than its calculated load." This statement bears out what was stated in an article written by the present author two years ago. It was then pointed out that activated sludge is a most valuable liquid manure, ready for immediate application to crops, that it can be conveyed to the land through pipes either by gravitation or by pumping. We have had in the past many efforts made in the direction of sewage irrigation, and some of them have been attended with a considerable degree of success. We have had irrigation with crude sewage, irrigation with partially purified effluent. Crude and digested sludge is applied to the land, sometimes with good results; but irrigation with a fully purified sludge having a high content of nitrate is an entirely different matter. If we have had partial success with land treatment by the older methods we ought to achieve complete success by the newer method.

Use of Sludge as Fertilizer.—The activated sludge process shows the possibility of conserving nitrogen and of accomplishing a thing that economists and sanitarians have had before them for many years past—namely, the full use of the sewage as a fertilizer; yet one sees that at such places as Sheffield, Birmingham and Bury the aim is merely purification. There is undoubtedly at the present time a general feeling that the process of purification ought to convert all organic matter into a fertilizer. It should be noted that Mr. Coombs, replying to the discussion

which followed the reading of his recent paper before the Institution of Sanitary Engineers, said:—"I am under the impression that in ten or twenty years time people will be smiling at us for having made such a bother about dealing with the sludge, because there is no engineering difficulty in the pumping problem, even of pumping 50 miles if necessary. . . . Mr. William Clifford has proved at Wolverhampton that there is no difficulty in dealing with the ordinary sludge in the neighbourhood of the sewage works by pumping it on to farms. If ordinary sewage, which has very little fertilising value, can be dealt with in that way, surely activated sludge can be dealt with even better. From September to May there would be no difficulty in irrigation in wet state; from May to September, which are the best drying months, there would be no difficulty in drying out on beds at Worcester. . . . The first big town which pumps activated sludge over a sufficient area of distribution will be pioneers of a practice which will be copied elsewhere."

Future Possibilities of Use of Sludge on Farms.—It seems reasonable to suggest that if wet sludge were pumped on to farms each farm might be supplied through a standpipe, which would be opened by officials of the sanitary authority as and when required. Naturally certain difficulties arise, such as wayleaves and easements owing to different ownerships, but the problem does not appear to be greater than in the case of sewers and water mains. It is possible that the sludge distribution problem on a very large scale might be taken over by the county council. No doubt every sewage works manager wants to make his works self-supporting, and wants to turn his sludge into a fertilizer, while every engineer wants to leave his scheme compact and self-contained. At present preliminary settlement has to be adopted in large towns so as to limit the volume of activated sludge produced. Small towns more conveniently placed may deal with their wet sludge by irrigation. The present is not the final condition. To pump the whole of the organic matter in London sewage to the country would naturally be a vast problem, but it is conceivable that this problem might be faced at some time in the future after smaller schemes have proved the method to be suitable and economical. Birmingham is situated at considerable elevation above the Severn Valley, and it would be easier to apply the method in this case, as the very wet sludge, which has a viscosity a little greater than that of water, could gravitate to the land. If the method is once proved to be economical and profitable for small towns, the larger cities may some day consider the matter seriously.

Variations of Activated Sludge Process.—It is interesting to note that the activated sludge process is appearing under different forms, and new names are given to what is really merely a combination of the activated sludge process with older methods. Mention has already been made of the "Sept-aer-sed" process in America, merely an adaptation of an older process tried in this country and apparently superseded. Mr. O'Shaughnessy, of Birmingham, takes tank liquor, aerates this for one hour, reaerates the sludge, and then passes the partially treated effluent over filter beds. This is called the "floculated sludge process"—a name which might produce the impression that it is a new process which has nothing to do with the activated sludge process. This work at Birmingham is interesting and valuable, but it is merely an application of the activated sludge process, the floculation of sludge being an essential feature of this process, and the Activated Sludge Company have always taken the view that the floculation of the sludge is all-important. This one feature, however, of the old process is taken as giving a new name to the Birmingham method. In the case of Sheffield, where the sewage is aerated and agitated by means of paddles we are becoming used to the name of bio-aeration, which name may be quite useful in describing a special process, but it would be equally applicable to the diffused air method or the method used at Bury, which is called "surface aeration." Finally, the Ministry of Health seem to have recently adopted the practice of referring to the method of Activated Sludge, Limited, as air blowing, although it appears that this company is not tied to the diffused method. These names may be useful, but it is open to question whether they are not merely one and the same process—namely, that of

purifying sewage in a tank by means of agitating and aerating the sewage, which work is done sometimes by diffusers and sometimes by various kinds of mechanical appliances.

Unnecessary Confusion.—It seems that various persons, notably in America, seem determined to make as much or perhaps as little as possible of the process. We read, for instance, that there is a growing tendency to give sewage a preliminary treatment before sending it through an activated sludge plant, and in general towards the adoption sooner or later of supplementary processes. Mr. Lee Peck, of New York City, boldly states that plant design should include preliminary treatment by sedimentation and skimming, shallow aeration, rapid removal of surface film, mixing it with the body of the liquor, agitation by mechanism, and acidulation of surplus sludge. He suggests aerating the skimmed and settled sewage before mixing with the activated sludge, and the use of catalysts to reduce power consumption, all of which may be of great interest and usefulness under special circumstances, but is not in agreement with the latest and best designs for works under normal conditions, and conveys the impression that what is really a very simple process is extremely complicated. From the chemical and bacteriological side the problem may be very involved. No doubt it is in many cases, and the work of the chemist may have an important bearing upon the design of the plant, upon the horse-power required, and upon the size of the tanks. From the engineering side the matter needs equal attention, and there are many possibilities, but certain facts are fairly obvious. It is useless to attempt to make out that a certain appliance will produce a result which we know very well it will not produce.

If a certain quantity of water has to be lifted to a certain height the horse-power can be calculated, and engineers pay no attention to claims for an impossible efficiency. If paddles, diffusers or other mechanical appliances are to be used we can tell what aeration can be obtained and what horse-power will be required. We know that with a given degree of aeration a certain tankage capacity is needed. Further, we know that if we have sufficient aeration we can treat all the organic matter.

A Water-Borne Typhoid Outbreak of Unusual Character

Pure Water Contaminated by Leaky Valve on Special Fire Service Connection Described in "Public Health News," Bi-monthly Publication of the Department of Health of the State of New Jersey

By CECIL K. BLANCHARD

Assistant Epidemiologist, Bureau of Local Health Administration, New Jersey State Department of Health

The outbreak of typhoid fever in Franklin, N. J., in November and December, 1922, due to the infection of a potable water supply after filtration and chlorination, again proves the danger of connecting a public water supply to any other system containing water unsafe for drinking purposes. The cause and results of this outbreak should indicate to any thoughtful person the folly of giving the protection of property against fire precedence over the protection of human life from disease and death.

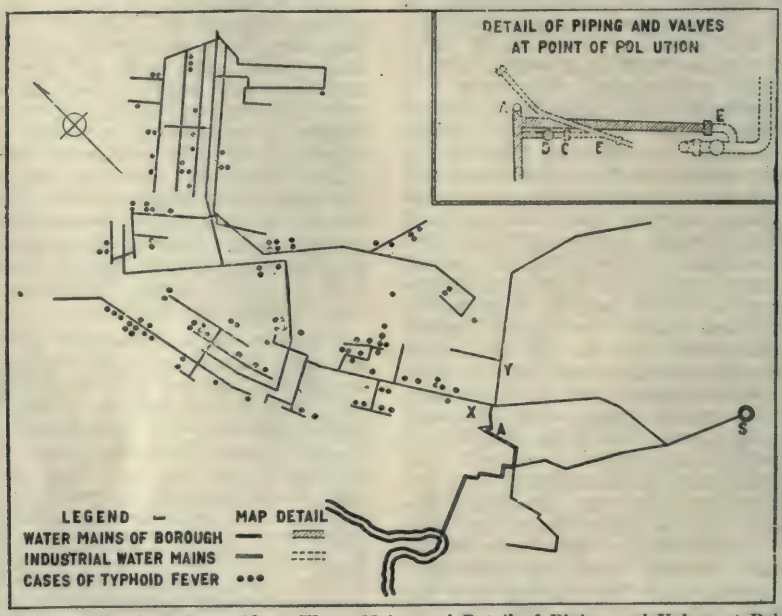
Franklin has a population of 4,000 and with some reason has claimed to be the ideal mining town of the country. Here is located one of the celebrated mines of the New Jersey Zinc Co., and great efforts have been made to protect the life and limb of the mine employees and to provide proper housing and recreational facilities, a safe water supply, unusual educational opportunities and public health service. The board of health employs a licensed health inspector who is also the school nurse, and three visiting nurses are employed by the zinc company. The water filtration and chlorinating plant has skilled supervision and its operation is checked by laboratory tests.

The local health department first recognized the presence of an epidemic on Nov. 18, 1922, and immediately requested the assistance of the State Department. One hundred and forty cases of illness had been estimated with tentative diagnoses of intestinal influenza, pneumonia and typhoid fever, but no cases had been reported to the board of health. The physicians were accordingly requested and agreed to submit lists of cases recently attended, with tentative diagnosis of each, thus providing within a few hours a record of all cases of severe illness in the vicinity. This

procedure is recommended, as it does not commit the physician to a reported diagnosis at a time when he still may be in doubt, and yet notifies the health department of the cases of suspected typhoid or other disease under investigation. Cases were later reported in the usual way.

While the early symptoms were not typical, there were a few cases which were evidently typhoid. Accordingly, specimens of blood from twelve cases in the third or fourth week after onset were examined at the State Laboratory and found to give the typhoid reaction. On Nov. 23 clinical diagnoses of typhoid were made by a pathologist called by the zinc company and by a number of the local physicians.

The Water Supply Is Suspected.—The case histories indicated that the public water supply was the only common vector of infection and that the cases followed the water mains from a point (X) near the center of the town northward. On the accompanying map of the water mains of the Borough the distribution of cases along these mains is clearly shown. At the point (X) a 4-in. pipe extended into the mine yard to a fire hydrant (A). On another branch (Y) connected to the street main about 15 or 20 ft. south of this point, and supplying a number of houses and a large public school, no cases were reported. The presumptive evidence, therefore, pointed to this 4-in. pipe as the probable point at which pollution entered the mains, since the flow past this branch is always northward. Investigation showed that this pipe in the mine yard of the zinc company was connected to a 6-in. line (E) containing raw water, drawn from the Walkill River for fire protection purposes. A gate valve separating the two systems was found closed, locked and covered with dust. A test with dye and 120-lb. pressure for two hours failed to indicate a leak at this point.



Distribution of Typhoid Cases Along Water Mains and Detail of Piping and Valves at Point of Pollution. A—Fire Hydrant in Mine Yard. B—Raw Water Industrial System. C—Gate Valve, Found Open. D—Check Valve, Found Leaking. E—Gate Valve Found Closed and Locked. S—Standpipe. X—Point Where Infection Entered Street Main. Y—Branch Not Affected by Pollution.

Failure of Check Valve.—Extensive excavation in this vicinity (A) later revealed the 4-in. pipe mentioned above to be connected to a 3-in. line (B) containing raw river water for fire protection and industrial use. The two water supplies were separated in this case by a gate valve (C) on the treated water side of which

was a check valve (D) designed to allow potable water to be used in the mine yard but to prevent polluted water from entering the street mains. Investigation proved that this gate valve was open, leaving the check valve as the only means of separation between a safe and a dangerous water system. Should this check valve leak, and the pressure of the raw water exceed that on the other system, there was nothing to prevent the pollution of the drinking water for the town with the dangerous river water. A test to prove this valve was at once arranged.

The plan was to introduce a green dye, uranine, on the raw water side of the gate valve (C) set all the valves as they had been when discovered, open the fire hydrant (A) on the treated water system and observe whether or not the green dye passed the valve (D) and colored the town drinking water. Night came before the test was ready for trial, but in the glare of automobile headlights, preparations were completed and the group of Health Department investigators, Company officials and workmen gathered about the hydrant as the water was turned on. The minute of silence and suppressed excitement was relieved by the gush of a bright green stream from the hydrant. Each witness saw before him the proof of pollution of the town water supply and the presumptive cause of the typhoid outbreak. The theory developed from the epidemiological evidence was fully supported by the conditions revealed by this test. It was later shown by calculation that the pressure on the industrial water system at the point of connection with the filtered supply exceeded the greatest possible pressure afforded by the standpipe (S) so that the flow would always be from the raw to the treated supply.

The conditions just described suggest the wisdom of taking samples for testing a water supply at several points, preferably near the distant ends of the distributing system. All attempts to determine when and for what reason the gate valve (C) was opened and by whom have been unsuccessful, partly due to the critical condition of one of the persons who was best acquainted with the operation of the water system who has not yet recovered from typhoid.

The officials of the New Jersey Zinc Co. rendered the greatest assistance and co-operation in discovering the source of the outbreak and applying effectual measures for its control. The company maintained a central office and clearing house for reports, records and information, and assumed entire charge of the hospitalization and home nursing of patients, the care of families afflicted by the epidemic, and the many similar problems which arose daily.

Bids Asked for Construction of Ocean Outfall Sewer for Los Angeles

Plans and specifications are now ready for bidders for the construction of the Ocean end of the new outfall sewer at Hyperion, bids for which will be opened by the Board of Public Works of Los Angeles, Calif., at 10 A. M. July 30th. This work consists of the installation, complete in place, of 429 12-ft. lengths of pipe having an internal diameter of 84 in. and 46 12-ft. lengths having an internal diameter of 60 in. Alternate proposals will be received for the installation of either Class D cast iron pipe of the standard bell and spigot type or submarine reinforced concrete pipe having special bell and spigot joint. The 84 in. pipe will be used for the first 5,145 feet from shore where the depth is about 50 feet. Here the 84 in. pipe will divide into two 60 in. branches at right angles to each other and 45 degrees from the main line axis. These 60 in. branches will extend 283 ft. farther from shore where the depth is approximately 56 ft. Special fittings for the pipe at the lower ends of these two branches will be made so that the sewage will discharge upward at a point about 4 ft. above the ocean bottom. The pipe will be laid just below the ocean bottom, which according to the borings consists almost entirely of sand and which has a slope of about 1 per cent from high tide outward. Piling is specified for a distance of 700 ft. through the surf and concrete aprons will be required around each of the two special outlet fittings. All pipe required will be furnished free of cost by the city at the Hyperion siding.

John A. Griffin is City Engineer and W. T. Knowlton is Engineer of Sewers of Los Angeles, Calif.

How the Water Works Coal Pile Can Be Reduced

Methods for Cutting Down Coal Consumption at Pumping Plants Outlined in Paper Presented May 25 at Annual Meeting of American Water Works Association

By DONALD H. MAXWELL,
Principal Assistant Engineer, Alvord, Burdick & Howson, Consulting Engineers, Chicago

The recent increased cost of coal and the troubles experienced in getting a sufficient supply and of the right quality have brought the coal pile forcibly to the attention of the water works superintendent.

There is no doubt but that the water works coal pile, taken as a whole, can be very much reduced. The consulting engineer is in a position to note many instances where pumping plant efficiency might be increased and others where pumpage might be reduced.

Developments in Steam Plant Economy.—The first requisite to coal economy is efficient equipment. Great strides have been made in the development of pumping plant economy since many of our older water works plants were equipped. In contrast to the hand fired return tubular boiler of small horsepower delivering saturated steam at 80 lb. pressure to duplex pumps of very low duty, modern practice calls for stokers, water tube boilers in large units, with superheaters and with good accessory equipment for maintaining high efficiency, and delivering steam at from 200 to 300 lb. pressure and superheated 100 to 200 degrees. The steam is utilized in cross-compound or vertical triple pumps with test duties ranging from 120 to 180 million foot pounds per 1,000 lb. steam.

The effect of this change on the coal pile is shown in part (except for superheat) by Fig. 1. This diagram does not take account of such auxiliary equipment as boiler feed pumps and the incidental uses of coal station heating, etc. nor does it allow for variation in load The station duty for a given set of equipment would, therefore, be less than indicated by the coal rates shown on this diagram. The diagram is based on coal having 12,000 B. T. U. per pound.

By inspecting the diagram we see that vertical triple expansion engines of 160 million duty using saturated steam supplied by boilers operating at 70 per cent efficiency would require 0.3 tons of coal to pump one million gallons 100 ft. high. On the other hand with compound direct-acting low duty pumps of 30 million duty using steam supplied by boilers of 50 per cent efficiency would require 2.2 tons of coal to accomplish the same result. One plant would consume seven times as much coal as the other to do the same pumping and it is a fact that many of our smaller steam plants compare no more favorably than this with the more modern high duty station.

Advantage of High Pressure and Superheat.—To understand the advantage in high steam pressure and superheat, it should be borne in mind:

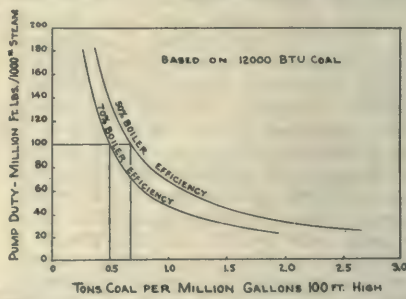


Fig. 1. Effect of Efficient Equipment on the Coal Pile.

1st. That steam engine efficiency increases with the steam pressure, amount in turbo-centrifugal pumps for example to about 1 per cent decrease in steam consumption for each 10 lb. increase in steam pressure.

2nd. That, in general, it does not take more coal (to an appreciable extent) to generate steam at relatively high pressure than at low pressure.

3rd. That engine efficiency increases with superheat, the gain with turbo-centrifugal pumps for example being approximately 1 per cent decrease in steam consumption for each 12° increase in superheat. The great advantage of superheated steam in reciprocating engines is that it does away with cylinder condensation (if superheated enough), so that all of the steam entering the cylinder is

available to do useful work throughout the stroke.

4th. That the additional heat required to superheat steam is much less than the heat saved by the engine so that there is a saving of coal. Assuming 100° superheat, this fuel saving amounts to about 4 per cent with a turbo-centrifugal unit, 8 per cent with a triple expansion engine and much more with compound and with simple engines.

Limitations of Water Works Plants.—The water works plant is long-lived compared to the industrial and electric power plant. The opportunities of business expansion, particularly in electric power production, make it good business policy to use only the most modern and efficient equipment. The coal bill in these plants is a relatively large part of the cost of power and accounts for the wholesale discarding of comparatively new equipment and even entire plants to make way for more efficient units of larger capacity in great central stations will enable the utility to command more business.

The water works plant cannot be rejuvenated in this sweeping way. The business of selling water is in most cities fully developed and can only increase in proportion to the growth of the city. The water works pumping station represents a comparatively small part of the total plant investment and the coal bill is also a small part comparatively speaking, of the total annual cost of the entire plant, including fixed charges. Furthermore the requirements for fire protection make it necessary, particularly in the small plant to carry a relatively large reserve boiler and pump capacity which is idle most of the time.

From these facts it is seen that the water works plant must move slowly in the procession of increased plant efficiency. Only occasionally when an entirely new plant is built to replace an outgrown and obsolete plant does the engineer have the joy of doing what he would like to do in making the plant up to date in efficiency of equipment. The more usual case involves more or less important additions to existing equipment, the limitations of this old equipment influencing at times very largely the character and efficiency of the new. It is not always financially practicable to change over to 200 lb. boiler pressure and 100° superheat, for instance, in a plant with heavy investment in low pressure pumps and boilers that are still good. The fixed charges on proposed new equipment must always be weighed against the estimated saving in cost of coal, and coal is not high enough yet to warrant the sweeping replacements in the average water works plant that have been good business policy in some electric power plants.

Planning for the Future.—Even though radical changes in pumping station equipment may not be justified when renewals are necessary, the superintendent has an opportunity at such times which should not be lost sight of, to map out an improvement program involving the entire plant. It would be most desirable, for instance, in replacing a boiler to make a survey of the plant and its future requirements and as a result, perhaps find it worth while to install a boiler at comparatively slight increased cost capable of withstanding a future higher steam pressure and arranged for the installation at a later date of superheaters. Then when the time comes to make pump replacements or additions the boilers will not be a handicap. Judicious provision for the future in this way will do much in the course of time to improve the small water works station efficiency without sacrificing useful equipment.

Boiler Plant Operation.—Meantime the water works operator must be contented to make the best use of the equipment now in hand. Even though the low pressure plant with low duty machinery must continue operating on this basis for some years a great deal can often be accomplished in these plants to reduce coal consumption by close attention to the details of operating that make for efficiency. The watch-word throughout the plant should be: "save the heat units." It might be said that intelligent and conscientious operation of a hand-fired low efficiency boiler installation is even more important for coal economy than in a plant with high efficiency equipment.

Coal saving is not possible without measuring and recording the internal workings of the plant. Between the heat input and measure of work output, there may be a very large preventable waste of energy amounting to from 25 per cent to 50 per cent of the coal pile in a poorly maintained plant. So it is not sufficient to know merely the tons of coal purchased and

the plunger displacement, and yet, astonishing as it may seem, plants are occasionally met with in which even this meagre information is not obtainable in a satisfactory manner.

The efficient operator must know the pounds of coal burned per hour for a given heat output in steam. He must know whether his customary methods of firing give the best results with the fuel at hand. He must know the effect of his practice in draft regulation as to whether the boiler is being unnecessarily cooled by too much excess air on the one hand, or on the other hand whether unburned gases are being wasted up the stack from insufficient supply of air to the furnace, and among other things he must know the effect of removing soot and

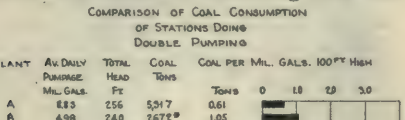


Fig. 2. Difference in Coal Consumption Between Stations of Same General Type.

boiler scale and how often it pays as a practical proposition to do this.

In a word, the operator should know whether he is wasting coal in the boilers. To find this out he needs the equipment and the interest to make routine boiler tests and periodic flue gas analyses.

An intelligent boiler room force and careful training in efficient methods are essential to economical operation. Furthermore, a suitable bonus system based on coal saved would be a valuable stimulus to interest in a coal saving program, if the possible savings seem sufficiently great to warrant it.

Pump Room Operation. — Pump room operation has a very large influence on the coal pile. The coal robber in this part of the plant is pump slip, though the preventable loss at the steam end may also be considerable.

The output of every pump room should be metered at the station unless there is some other convenient method of checking up on the pump slip, at frequent intervals. The use of venturi meters on discharge lines has become quite general, but there are still many plants which lack proper equipment of this kind. These plants are as a rule paying heavily for it in the coal pile.

The writer has had occasion to observe some startling results from high pump slip, and there is good reason to believe that this is one of the principal causes of coal waste in many of the stations that lack proper means of measuring the water delivered by the pumps.

Table I shows the result in one plant of reducing pump slip. The records of this plant for several years shows a continual increase in the tons of coal burned per million gallons pumped. The coal bill finally became so high that it was decided to have the pumps rebuilt. The effect of improved efficiency of the steam end and of reducing the pump slip is very strikingly illustrated by a reduction in the coal consumption amounting to 67 per cent of the coal burned in 1922. Comparison of the 1922 pumpage with that of the two preceding years shows a very marked reduction in pumpage as indicated by plunger displacement.

Table II shows the effect on the coal pile of introducing a high duty pump to do the work formerly carried on by low duty pumps. In this plant under the same conditions of operation the high duty pump accounted for a

Table I—Effect of Reducing Pump Slip on the Coal Pile

Year	Plunger Displacement, Million Gals.	Coal Burned Tons
1919	263.1	1,124
1920	299.9	1,288
*1921	304.8	1,264
1922	287.9	770

*Rebuilt pump back in service in November.

Coal saved in 1922, 518 tons=67% of 1922 coal pile.

Table II—Effect of Higher Duty Pump on the Coal Pile

Year	Pumpage Mil. Gals.	Per Cent of Time New Pump Used	Coal Tons	Coal Per Mil. Gals. 100 ft. High
1910	1,839	.....	4,626	1.01 Tons
*1911	1,919	.....	4,878	1.01
1912	2,090	60.9	4,749	0.965
1913	2,241	90.7	4,403	0.842
1914	2,272	92.6	4,562	0.810

Coal saved in 1914: 1,030 tons=25% of 1914 coal pile.

*Cross-Compound pump of 142 million test duty installed.

Table III—Value of Testing Pump Slip as Measured by the Coal Pile

Average Daily Pumpage	12,000,000 Gallons
Slip	3,750,000 "
Slip reduced to	700,000 "
Total head 153 ft.	
Coal per Mil. Gals., 100 ft. High	0.928 Tons
Coal Saved per Year	1,570. "

saving of over 1,000 tons per year amounting to 25 per cent of the 1914 coal pile.

Table III is a rather striking illustration of the very large coal saving sometimes possible in a comparatively small plant by eliminating excessive slip in a high test duty cross-compound pump. The saving in this case was at the rate of approximately 1,600 tons per year, although inspection of the records tended to show that the excessive slip found on test had lasted only about four months. The record of plunger displacement indicated, however, that up to within one week of the test the slip had been materially higher than indicated by the test, and had been partly corrected by replacing pump valves.

Figure 2 illustrates the great difference in coal consumption between stations of the same general type. These are all double pumping stations in small or moderate sized cities operating for the most part under direct pressure. Plant "A" is an eastern

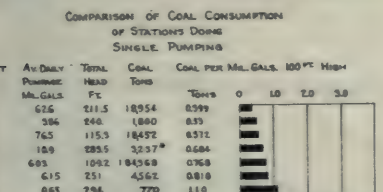


Fig. 3. Comparison of Coal Rate for Modern and Old-Fashioned Stations.

plant burning Pennsylvania coal. The others are western plants burning Indiana or Illinois coal. The high coal consumption of plant "G" may be partly attributed to wide range in low lift pump head. In plant "H" it is due partly to poor plant design. In Station "I" the poor showing is due in part to very inefficient low lift pumping from the use of over-sized electric centrifugals, the low lift pumping being accomplished at an overall efficiency of 15 per cent for pumps and motors.

Figure 3 indicates the typical low coal rate that expected of well designed and operated modern stations doing single pumping, and to contrast with them the old fashioned stations with low pressure boilers and low duty pumps. Plant "A" is the North Point station at Milwaukee equipped with vertical triple expansion engines of high test duty of about 180 million foot pounds. Plant "B" is an efficiently operated small station burning Pennsylvania coal in hand-fired boilers and pumping with cross-compound engines against constant head. "C" represents the newest and most efficient of the Chicago pumping stations, pumping direct pressure with vertical triple and turbo-centrifugal pumps against a total lift of about 115 ft. Steam is generated by water tube boilers operating at 175 lb. pressure. "E" represents the average of all Chicago stations considering steam pumping only. At three of the Chicago stations a large amount of pumping is done by motor driven centrifugals using central station current. At these stations the coal duty has been greatly decreased from their former performance which is probably to be accounted for by the unfavorable load on the steam plant. 22nd St. now shows a coal rate of 1.41 tons per million gallons, 100 ft. high compared with .83 in 1910 and 68th St. shows a coal rate of 1.3 tons compared to .85 in 1910.

Plant "D" is the new Des Moines station with stoker fired boilers 200 lb. steam pressure and 100° superheat pumping with turbo-centrifugals of 143 million foot pounds test duty. It should be noted that this plant operates on Iowa coal containing from 8,300 to 8,800 B. T. U. per pound. The boilers on test showed 75 per cent efficiency at full load and 66.5 per cent at 168 per cent overload. The plant operates direct pressure. It should be noted particularly that this plant burns a much lower grade of coal than the Illinois steam coal used at Chicago.

Station "F", the old Des Moines pumping station should be compared with Station "D". This station, with hand-fired return tubular boilers and a cross-compound pump of 140 million test duty operating on 125 lbs. steam pressure required 20 per cent more fuel than the new station to accomplish an equivalent amount of pumping.

Station "G" indicates good performance in a fairly well maintained plant operating under 90 lbs. steam pressure and duplex compound pumps in good condition operating direct-pressure under a high head. Station "H" in contrast to "G" represents very poor performance in a plant having equipment of the same general character and burning just as good coal. This latter plant showed 50 per cent

boiler efficiency on test and 25 per cent pump slip.

These few illustrations show that although some pumping plants are operating on a highly efficient basis, there are others where large quantities of coal are being wasted. In some of these instances the fault lies in the plant installation, and can only be overcome by putting in better equipment. In others a great deal can be accomplished to improve the plant efficiency by systematically checking up on pump slip, boiler firing methods, draft regulation, and all the other details of operating that affect the size of the annual coal pile.

Public Utility Rates for Kansas Cities

A compilation of water, electric light and power, gas and telephone rates for 542 Kansas cities has been published by the League of Kansas Municipalities, of which John G. Stutz, Lawrence, Kan., is secretary. The bulletin contains considerable information regarding the utilities in addition to that on rates. For the water works it gives the source of the supply, its treatment, meter service, the capacity of the plant, the rates for city service, minimum bills, and whether the plant is a paying proposition or not. Similar data are given for the electric light and power plants.

Moving 18,000 Cu. Yd. of River Sand by Hydraulic Elevator

By R. FRANKLIN MUNDORFF

Following the construction of the concrete dam at Decatur, Ill., it was desired to pack sand under the edge of a horizontal concrete apron. The particular job presented the problem of moving 18,000 cu. yd. of sand in a river to a new location 400 ft. away in a deep hole in the river bed.

The hydraulic elevator method was adopted, as there was available the amount of high-pressure water required for its operation and because all the wear on the equipment would be centered entirely on the manganese steel throat of the elevator, and a small inexpensive barge would accommodate all necessary equipment and the pumping unit could be mounted on the shore.

View of Pipe Line and Arrangement for Supporting Suction Nozzle.

The elevator was placed horizontally on a small barge and the water pressure line was brought aboard on barrel pontoons. This line was fitted with 10-in. by 10-ft. rubber sleeves at both the shore and barge ends.

The suction consisted of a 10-ft. length of 8-in. rubber hose and two lengths of 8-in. pipe. This was supported by block-and-tackle extending was raised and lowered by a hand winch.

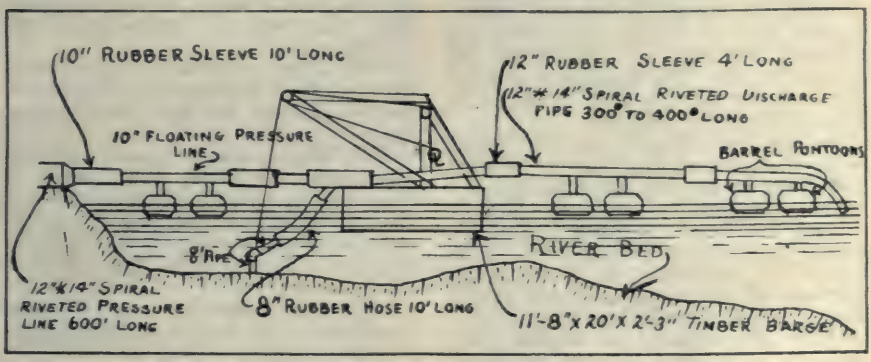
The discharge line, varying from 350 to 400 ft., was supported by

barrel pontoons, the discharge end being submerged to eliminate a static head against the elevator.

A large reciprocating pump with valve gear was used to supply the pressure water. The actual results obtained were from 50 to 60 cu. yd. of sand per hour, exclusive of the time used for changing the location. The pressure at the pump was 80 lb. per square inch, which gave a pressure of 70 lb. at the elevator nozzle.

The elevator would begin to pick up sand at 25-lb. nozzle pressure and would work well at 40-lb. pressure. No improvement was noticed above 70-lb. nozzle pressure.

The installation was made by George B. Massey of the Randolph-Perkins Co. of Chicago, Ill., for the city of Decatur, Ill.



Arrangement of Equipment for Moving 18,000 Cu. Yd. of Sand.

Activated Sludge Studies

The results of the investigations of the activated sludge process of sewage disposal carried on by the State Water Survey Division of Illinois, of which A. M. Buswell, Urbana, Ill., is chief, has been published in the form of a bulletin. The bulletin gives a brief historical survey of progress in the development of the activated sludge process of sewage disposal, and with this historical view as a background presents the chemical and biological data which have been collected during the past year's experimentation with low air operation of an activated sludge plant treating 75,000 gal. per day.

Locating Leaks in Underground Pipe Lines With the Geophone

Mr. H. A. Ward gives the following information in Mechanical Engineering regarding the use of the geophone, an instrument developed during the war for detecting vibrations of the earth due to tunneling, etc., in locating leaks in underground piping systems of an eastern university:

The first leak was in the return of the heating system and was located accurately under 4 ft. of cover.

The second leak was in a domestic hot-water pipe encased in a concrete duct packed with mineral wool and under 4 ft. of cover. The line extended from a tunnel to a building 250 ft. away. The evidence of the leak appeared as warm water from the underdrain into the tunnel. The leak was located 200 ft. from the tunnel and proved to be a pit hole in the pipe about $^{3}/_{16}$ in. in diameter.

The third case was in a 5-in. steam line carrying 10 lb. steam pressure. The line is encased in a concrete duct. Thce leak was located at a point which proved to be 9½ ft. underground.

In all these cases the leaks were plainly audible for ten or more feet each side of the point at which it was finally decided that the disturbance was loudest. In each case the first excavation put down centered on the leak.

The instrument and some of its applications are described in Technical Paper 277, Department of the Interior, Bureau of Mines, Washington, D. C.

Assumptions for Sewer Design in New York City

Sewer design is now to a large extent uniform in the five Boroughs of New York City. Certain rules relating to outlets were adopted by the Board of Estimate and Apportionment in 1917, but there are also various assumptions adhered to by mutual consent in the preparation of sewer plans. Some of these assumptions are given as follows in a special sewage disposal bulletin issued recently by the Board of Estimate and Apportionment of New York City:

The average dry weather flow from the resident population of any section is taken to equal the average water supply plus a certain allowance for average leakage or infiltration of ground water. The maximum rate of dry weather flow is then assumed to be 1½ times the average.

Infiltration depends on the depth below the ground water level. Where the sewer invert lies above the ground water, infiltration will be absent. Where the invert is from 0 to 5 ft. below the ground water level, infiltration is estimated at 20,000 gals. per mile of sewer per day, and where the invert is at a greater depth infiltration is estimated at 40,000 gals. per mile, or about 1,560 gals. per acre, per day.

Sanitary sewers in which the dry weather flow will amount to 10 cu. ft. per second or more are designed large enough to carry twice the mean dry weather flow, with an added allowance, where necessary, for transients and industrial wastes.

Intercepting sewers are designed to carry from 2 to 3 times the estimated average water consumption plus 1½ times the average infiltration.

In computing the capacity of sewers by the Kutter formula, the coefficient of friction is assumed at:

.012 for wood stave pipe

.013 for cast iron and vitrified pipe

.013 to .015 for concrete and brickwork.

Minimum velocities are provided, where practicable, of at least 2.25 ft. per second in separate sewers and 2.5 ft. per second in combined sewers.

Sanitation Project in Peru.—The so-called Peruvian sanitation loan of $25,000,000, it is reported, has been arranged. The Banco Italiano at Lima is representing the banking interests.

Criteria for Earth Dam Design

In a paper, "The Design of Earth Dams," presented May 2 before the American Society of Civil Engineers, Joel D. Justin summarized the practical criteria for the design of earth dams as follows:

"An earth dam should be designed so that:

"(1) The spillway capacity is so great that there is no danger of overtopping;

"(2) The line of saturation is well within the down-stream toe;

"(3) The up-stream and down-stream slopes must be such that, with the materials used in the construction, they will be stable under all conditions;

"(4) There must be no opportunity for the free passage of water from the up-stream to the down-stream face;

"(5) Water which passes through and under the dam, must, when it rises to the surface below the toe, have a velocity so small that it is incapable of moving any of the material of which the dam or its foundation is composed;

"(6) The freeboard must be such that there is no danger of overtopping by wave action.

"All rules have their exceptions, and it cannot be stated positively that any dam which does not meet fully all the foregoing criteria will be unsafe. It will be found, however, that with the few safe dams which do not fully meet all these criteria, some special means have been adopted to overcome the difficulty. For instance, the writer knows of one earth dam, 60 ft. high, founded on ledge rock with practically no soil cover. The engineer recognized that the down-stream toe would be saturated, under these conditions, and placed a heavy rock fill against the toe. A small quantity of water issues from the toe of the rock fill, but the velocity is so low that the material of which the dam is composed is not disturbed.

"An earth dam, designed and built to meet these criteria, will prove as permanent as any of the works of man if proper attention is given to important details during construction."

Sewer Systems in Kansas.—Of the 542 incorporated places in Kansas, 147 have sewer systems.

Engineering Work for Large British Irrigation Project

Method of Making Surveys and Designs for Murrumbidgee Scheme, New South Wales, Described in Paper Read Before Leeton (N. S. W.) Branch of Water Conservation and Irrigation Commission

By J. M. S. WOORE

The following brief notes on surveys and the design of subdivisions and minor works in connection with an irrigation scheme are mostly based on experience and practice with regard to the Murrumbidgee irrigation scheme. It must be borne in mind that every irrigation scheme is more or less in the nature of an experiment and has its own problems to solve in a manner best suited to local conditions. As an illustration of this it may be stated that considerable areas of what would otherwise be considered as first-class irrigation land are being excluded from settlements on the Murray on account of danger anticipated from injurious salts. On portions of the Murrumbidgee irrigation scheme there are difficulties of an opposite nature, and problems in connection with an impervious subsoil have to be dealt with.

Contour Surveys.—Assuming that preliminary surveys have been completed and sites located for the headworks and dam, or pumping station, a very careful major contour, feature and classification survey is then necessary to serve as a basis of design. To provide a framework for the survey, main lines are set out at right angles to each other so as to form a chess board system with squares of about one mile on the side, any convenient surveyed line being taken as a base line. According to the practice now in force, a heavy post is placed at each intersection to serve as a connection for the channel surveys and numbered so as to identify the corner. A bench mark is cut on the nearest suitable tree, or if there are no trees available the bench mark is formed on the intersection post and specially carved with the surveyor's distinguishing letter.

When the main lines are set out, pegs are driven at intervals of 900 ft. or as necessary, preferably on the east and west lines so as to form temporary bench marks when the cross sections are taken. The bench marks and temporary bench marks forming the foundation of the survey are then carefully levelled and checked levelled, any small errors being adjusted. It is preferable that the bench marks should first be established over a fairly large area comprising a group of the squares referred to. Sections are then run from peg to peg and spot levels taken each side so as to form a system of levels 300 ft. apart, or as required to suit the country. The surveyor should also pick up any marked irregularities of the ground between the regular spot levels.

All natural features, nature of timber, improvements such as fences, buildings, dams, etc., are located and described, and it is important that corner posts of any existing surveys should be connected with the contour survey.

A classification of the soil is carried out simultaneously with the major contour survey, the nature of the soil and subsoil being carefully recorded in the field notes. Trial holes are sunk about 2 ft. 6 in. deep on the section lines about 900 ft. apart, or as necessary, and the classification of soils should be carried out in a uniform manner. All boundaries defining changes in the nature of the soil, areas of rocky patches, and the limits of land unfit for irrigation through any cause should be clearly defined in the field notes.

It should here be mentioned that after the subdivisions have been surveyed and the land cleared of timber, a minor contour survey of each farm is made with spot levels 1 chain apart, the intersections being located by a system of flagging which is described in the commission's regulations. From the minor contour survey a plan of each farm is prepared showing contours at 3-in. intervals. This plan is supplied for the information of the settler, and so that a design of each farm may be prepared if necessary, showing location of farm ditches and other information.

Returning to the major contour survey; when the field notes are complete the levels and other information are plotted to a scale from 8 chains to 4 chains to the inch, according to the nature of the country, the plot of any existing subdivisions serving as a ground work for the plan, and contours are then drawn in at intervals of 1 ft. in level.

Subdivision Designs.—The major contour plan forms the basis of design for the new subdivisions for irrigation farms, but it is customary first to estimate whether the section under consideration is suitable for dairy farming, fruitgrowing, or other purpose, and then prepare a preliminary design on a reduced scale, the areas of the farms being fixed approximately according to the classification and general knowledge of the country. With the help of this plan it is now the usual practice for a preliminary inspection to be made with the agricultural expert for the commission and the areas reduced or increased according to this officer's advice. The detail design is then prepared on the large scale plan.

There are two main systems for subdivision designs, the strictly rectangular system, where the land is subdivided on a regular plan into rectangular blocks and the location of the channels in relation to the farms is considered as a secondary matter, and the more scientific system as adopted here and elsewhere in Australia, where the channel system is considered of first importance and the farms are designed to suit the contours, and so that they may be watered in the most convenient manner; intersections of farms by channels being avoided as far as possible.

At Mildura, in Victoria, the settlement has been laid out on a strictly rectangular plan which does not correspond with the contours, the channels being located without reference to the subdivisions and crossing the farms in all directions. In later irrigation schemes in Victoria the rectangular plan has been abandoned and subdivisions designed to suit the contours. In India and the United States of America the rectangular plan is adopted, but the minor channels are located as far as possible so as not to intersect the farms.

Over comparatively small areas where the slopes are regular, a rectangular plan can be obtained even when the general design is based on the contour system, but no attempt is made to sacrifice other advantages for this plan. The main principles are that the cost of works and waste space should be reduced to a minimum, and the farms laid out on as regular plan as possible, consistent with ease of watering; intersections of farms by channels and drains should be avoided as far as possible.

All such matters as number, width and direction of roads, width of reserves required for channels and drains, grades and costs of main contour channels, etc., cost of bridges and other works, provision for railways, village sites and public utilities have to be kept in mind, as well as many other matters which, like the "other articles" of the auctioneer's advertisement, are "too numerous to mention."

Speaking generally, the method adopted is to locate the main channel lines on the higher ground or ridges and drains on the lower contours or in the depressions or water-courses. Where the slopes flatten out and the ground is fairly regular the smaller channels may cross the contours in parallel straight lines. In country where there is an even step slope one way it is economical and probably more convenient for watering and drainage to provide for parallel contour channels with tiers of farms between them. Where the slopes flatten out and there is still a fairly even fall, it seems more advantageous to run parallel laterals nearly at right angles to the main feeding channel or branch canal. This design is probably more economical in the case of flat slopes, as the laterals can usually be of smaller capacity and often a better grade can be obtained. The grade of a canal or main contour channel is an important matter and depends mostly on the slope of the country and the value of the land. Where the slopes flatten out and first-class land is met with it may be advisable to reduce the grade very considerably so as to take in a larger area—the annual return expected from the extra land taken in should balance the interest and depreciation charges on the extra cost of construction. It will be found that as the size of a channel increases the extra cost of construction due to increasing the sectional area or flattening grade decreases.

Grades of main canals and contour

channels usually vary between 2 ft. and 6 in. to the mile. On account of the higher cost of construction the grades of concrete or mortar lined channels should be made as steep as possible. The location and grades of contour supply channels is a matter which has to be carefully considered in connection with the subdivision designs. There is not much choice as a rule as to grades of drains, which are generally located so as to obtain the best fall possible.

Subdivision and Channel Surveys.—When the subdivision design has been approved the channel lines and subdivisions are set out and surveyed on the ground. When setting out supply channels and drains the surveyor should take the contour plan as a guide, and not work from the plan by scale only, and it is necessary that all corner posts and intersections of the major contour survey should be picked up when locating the channels, so that the latter will be in their correct position in relation to the contours. In setting out contour channels considerable judgment is required, so that a reasonably straight line may be obtained without too much cut or fill. In broken country it is a mistake to endeavor to follow the contour too closely, as the cost of construction is involved in the extra length of channel and additional curves might easily counterbalance any saving in earthwork, especially if the channel is to be lined. The subdivision surveys must be carried out to correspond with the channel lines, and the channel surveys should either be completed beforehand or the two surveys worked together.

Grading and Capacity of Supply Channels.—On completion of the channel surveys the sections are plotted, sectional areas and capacities fixed, and channels graded in the most economical manner as regards actual construction. Assuming the capacity to be constant, the condition for minimum sectional area is that the depth should be twice the hydraulic radius, but this rule can be seldom realized in practice, as the depth would be too great and side slopes too steep for economical construction by the ordinary methods. The condition is nearly fulfilled in our small lined channels with slopes of 45 deg. and depths equal to the bed widths. For average size earth channels of the usual proportions the depth is about 1½ times the hydraulic radius, and for main canals with a bed width of, say, 50 ft., the depth is nearly equal to the hydraulic radius.

In order to obtain as regular design as possible the majority of the smaller channels or laterals are located in straight lines and are not designed to any fixed grade, the method adopted being as follows:—

The full supply level at each farm outlet is fixed at a certain margin above the highest point of the farm which it is considered economical to water; this margin is usually taken as from 3 in. to 6 in., and depends on the loss of head in the meter, grade of farm ditches, contours of farms, and other factors. The flow line is then fixed so as to allow for the full supply levels already determined and so as to balance the earthwork quantities as nearly as possible, any spoil required being provided by enlarging the section of the channel, borrowing from banks of adjacent drains, or in extreme cases from tanks excavated within the farm boundaries. Side cuts are avoided as far as possible, as they tend to harbour noxious weeds and are objectionable from other points of view.

The draftsman engaged in grading supply channels and drains should continually refer to the contour plan, and as the grading proceeds should show on a copy of this plan, the approximate areas assumed to be not commanded, too low to be drained or subject to flood, together with full supply level at farm outlets and bed levels of drains. This information is afterwards checked and utilized in the preparation of particulars for gazettal of farms. In many cases the size of the smaller earth channels or laterals is governed by the amount of spoil required for the banks and not the actual capacity.

In concrete or mortar lined channels, however, where saving of material is the first consideration, the sectional areas should be reduced to a minimum and the best grades possible obtained. On account of the great expense of channel lining the capacities of the individual channels should be reduced to a minimum. consistent with economy in working and convenience to the settler.

The general method recommended is as follows:—A convenient district is assumed for a water bailiff, containing, say, 50 to 70 farms, if the

original system is a large one it may be assumed as divided into two districts. The stream required to water the district in the given rotation period will then be in cusecs:—

$$\frac{\text{Total irrigable area in acres} \times \text{assumed depth of watering in ft.}}{\text{Rotation period in days} \times 2.}$$

and allowance should be made for losses, say, 10 per cent. in the case of lined channels.

The total flow is then considered to consist of a number of unit streams of one cusec, and each class of farm is assumed to take one or more or a fraction of such stream according to its irrigable area and the purpose for which it was designed. Thus a 20-acre horticulture farm may take one unit stream of 1 cusec, a 250-acre dairy farm with a water right of 80 acre ft. may take three unit streams, and so on. The main branch or feeding channel should obviously be of the full capacity until a point is reached where the number of unit streams required is equal to the total flow; the capacity can then be reduced as required after passing each farm outlet. The laterals feeding from the main branch are designed so as to be gradually increased in capacity from the last outlet downstream until the full designed capacity is reached.

This system assumes, of course, that as far as possible the water distribution from each lateral will be completed before passing on to the next one, so that a minimum number of offtakes will be in operation at the same time. This method is the most convenient and economical as far as water distribution is concerned, but somewhat increases the cost of the channels. If it were permissible to dodge about from one lateral to another over a wide area so as to have a large number of offtakes in operation at the same time, the size of the channels could be considerably reduced, but the cost of operation and inconvenience to the settler would be correspondingly increased. When a number of short isolated lined channels are taken off a main branch or main canal at frequent intervals no very definite system can be followed out. It is usually sufficient to fix a reasonable maximum capacity, say, 12 cusecs, and then deal with each lateral as explained above.

Surface Drainage.—A complete system of surface drainage for storm waters and waste water from irrigation is provided. So far, except in isolated cases, there has been no serious trouble due to rise of water plane or undue accumulation of injurious salts, and it is hoped that the question of deep subsoil drainage may be deferred for many years. Wherever possible, main drains are taken right through to the Murrumbidgee River or Mirrool Creek. There is usually a difficulty in obtaining sufficient fall, and owing to the flat nature of the country, grades of 6 in. to the mile over long distances are often necessary.

It is assumed generally that a surface drainage system cannot be provided of sufficient capacity to run off water due to heavy rainfall as quickly as it falls, and some temporary accumulation of flood waters is unavoidable. Structures such as culverts and subways should be designed so as to be roughly proportioned to the catchment areas, and drains and structures should be increased in size where the slopes are steep or in the vicinity of a range of hills. This precaution is specially necessary where a large body of water is concentrated at a few points by means of contour drains skirting the hills. Drains are located as far as possible on road or special reserves outside the farm boundaries, and where the intersection of farms cannot be avoided, the channels should not pass through small swamps or depressions which are too low to be drained, but should be deviated so as to pass round them.

Structures.—On every irrigation scheme there is a very large number of structures to be provided for, such as bridges, regulators, checks, culverts, subways, offtakes, farm outlets, etc., as well as special structures such as pumping stations, factory buildings and works in connection with roads, streets, town water supply, sewerage, etc. It is of course of great importance that the design of irrigation structures should be as economical as possible, the best use being made of the most suitable materials obtainable in the district.

Sufficient supplies of suitable timber being now unobtainable at a reasonable cost, it has been found more economical to adopt reinforced concrete as the standard form of construction in almost every instance. This form of construction is practically permanent and has the ad-

vantage of requiring very little expenditure in maintenance. It is essential of course that sufficient steel be provided at all places where according to calculation or judgment tensional stress in the concrete is likely to develop, and careful attention should be directed to such matters as providing sufficient area for bond and ample length of steel for proper anchorage of bars in retaining walls and similar structures. As the cost of form work is often about 25 per cent of the total, every endeavor should be made to design structures so that forms may be easily removed and their cost reduced to a minimum.

The standard type bridge for the main canal may be taken as an example of simple design, and consists of a plain slab deck in several spans of not more than 12 ft. 6 in. On account of the comparatively low cost of forms it has been found that this structure is more economical than a bridge with longer spans of tee beam and slab construction.

The question of foundation and floors to bridges and regulators is important, especially if the soil is of a porous nature and sufficient length of floor and cut off walls should be provided to reduce the rate of percolation and the upward pressure on the downstream portions of the floor to a safe limit, when the water is held up on the upstream side only. The question of the design of reinforced concrete is so intimately connected with constructional methods that it is difficult to separate the two subjects. If the engineer responsible for designs is not also in charge of construction he should at least frequently confer with the construction engineer and make inspections of works in progress, and only by co-ordination of this kind can economical and successful reinforced structural work be carried out. Such matters as mixing, placing and consistency of concrete, setting up and removal of forms, tying reinforcement and securing the bars in place in correct relation to the forms, and many other questions, a knowledge of which is so necessary for drafting a specification, can only be learned by practical experience.

Pumping Schemes.—Where large areas of first-class land at a reasonable distance from the head works are not commanded by gravitation, it becomes a question for consideration as to whether such lands should not be watered by pumping, rather than extend the gravitation scheme to the utmost limit required to dispose of the available water rights. One such scheme comprising about 3,000 acres is already in operation on the Murrumbidgee Irrigation Area, and others are proposed.

A pumping station should be located so that the length of rising main is as short as possible and should be in a convenient position for the transmission of power or transport of fuel. If steam or suction gas be adopted the station should, if possible, be adjacent to a railway to avoid expense in carting coal, etc. Centrifugal pumps are now almost generally adopted for irrigation purposes, and can be designed with a high efficiency both for low and high heads; they have few parts which are likely to get out of order and require very little attention. They are cheaper and occupy less space than reciprocating pumps. The type with horizontal split casing should be adopted for irrigation works, as this pump can easily be opened up and cleaned of floating woods and other trash. Centrifugal pumps are specially adapted for electric power, and very high efficiencies can be reached with direct coupled sets. When considering the pumping station careful design of the suction pipe and connections is necessary so that the water might enter with a low velocity which should gradually increase as the eye of the pump is approached. In order to avoid air locks the upper line of the suction pipe and any reducing pieces should be level or have a slight fall towards the suction well. It should be borne in mind that if two or more centrifugal pumps are intended to deliver into a common rising main they should be of exactly the same design with similar head-speed curves, otherwise the pressure developed by one pump would be liable to stop the others.

Speaking generally as regards the design of all structures and plant, the most economical design is that for which the annual charges, consisting of cost of operation, maintenance and interest and depreciation on capital cost are a minimum, but another very important matter is the actual provision of the capital required. An engineer often has to be satisfied with a cheaper design as regards capital

cost, with correspondingly increased annual charges.

Various Matters in Connection With Irrigation Design.—In addition to the subjects already dealt with there are many other matters in connection with the design of an irrigation area, such as town planning, the design of ornamental parks and plantations; municipal work, such as roads, streets, town water supply and sewerage disposal works, factory buildings, etc., etc.

The provision of railway facilities is an important matter which affects the welfare of an irrigation settlement, and in the preparation of subdivision designs and town planning, ample provision should be made for main trunk lines, spur lines, station yards and sidings to factories, etc. As on an irrigation area, it is usual to group together allotments reserved for industrial purposes; considerable care should be exercised in designing a system of sidings which will be convenient and economical in operation, and due allowance should be made for future large increases in traffic.

The two main points to be considered are that the system of sidings should have direct access to the nearest station yard without unnecessary shunting, and that running or traffic roads should be provided distinct from the sidings on which trucks will stand for loading or unloading, so that the engine will be able to drop or pick up trucks from any part of the system without interference with loading operations.

Among the many subsidiary matters connected with irrigation design the agricultural aspect of the work should not be neglected, as it is closely connected with the design of subdivisions and works. Some acquaintance with soil classification in relation to irrigation is necessary, and a knowledge of the various crops and products which can be profitably grown in the district, together with the amount of water required for each and the approximate average returns to be expected per acre. Some practical knowledge of irrigation may also be very useful, and will assist the engineer in dealing with the numerous applications and requests from the settlers in a sympathetic and intelligent manner.

Work of the U. S. Reclamation Service

The Reclamation Service of the Interior Department has completed a summation of its work conducted since the reclamation act went into effect 20 years ago. The following summary from the May Reclamation Record shows that operations of the department in irrigating arid lands have reached great proportions.

The water-storage capacity of irrigation project reservoirs of the Department of the Interior in Western States has now reached 10,000,000 acre-feet, or enough to cover the entire State of Connecticut with 3 ft. of water.

The number of projects now under way or completed embrace upward of 3,000,000 acres of land that may ultimately be irrigated and divided into 70,000 farms, ranging from 10 to 160 acres. Water is already available for over 2,000,000 acres on more than 44,000 farms.

The construction of irrigation projects has included over 12,500 miles of canals, ditches, and drains; tunnels, with an aggregate length of over 27 miles; masonry, earth, rock-fill, and crib dams, with a total volume of 14,000,000 cu. yd.; over 8,000 bridges; 560 miles of pipe line; 130 miles of flumes; 1,000 miles of wagon road; 83 miles of railroad; 3,000 miles of telephone lines; 970 miles of transmission lines; and 1,450 buildings, such as offices, residences, power plants, pumping stations, barns, and storehouses. The excavation of rock and earth amounts to about 200,000,000 cu. yd., equivalent to an excavation 1 mile on a side and nearly 200 ft. deep. Excavation during 1922 exceeded 1,000,000 cu. yd. a month.

The Reclamation Service has used over 3,000,000 bbl. of cement and has manufactured over 1,500,000 bbl. of cement and sand-cement. It has mined 140,000 tons of coal. The irrigation works incidentally develop approximately 64,000 h.p.

Compensation for Typhoid Fever Under Workmen's Compensation Act.—Typhoid fever contracted by an employee of a hotel as the result of drinking impure well water furnished by the hotel has been held compensable as an accident within the meaning of the workmen's compensation act by the Supreme Court of Michigan.

Construction of Water Works Intakes

Various Factors Including Types of Cribs, Protection of Intakes and Size of Intake Pipe Described in The Canadian Engineer

By ROBERT W. ANGUS,
Professor of Mechanical Engineering, University of Toronto

There are many sources of supply, and it will not be possible to discuss this phase of the question under the title of this article, but it may be said that only the supplies obtained from certain rivers and large ponds or lakes are of interest in this connection, because in these cases many peculiar and special problems present themselves. More especially is this the case in exposed places, where, due either to rough weather or swift flowing water, there is difficulty in keeping the structures in place.

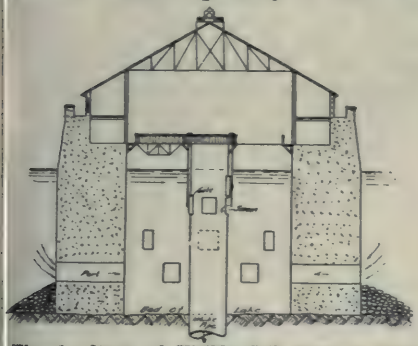


Fig. 1.—Form of Visible Crib Used in Great Lakes.

In such cases as these, an intake of good construction must be built which must have the important properties of being able to draw an ample supply of water as free as possible from turbidity and impurities of various kinds, and always fully dependable. Naturally, where the supply is drawn from the great lakes, the intake must be very well built and its location very carefully selected.

Intakes in the great lakes are used by many large cities such as Toronto, Chicago, Cleveland, etc., and in every case the end of the intake pipe or tunnel must be protected by a crib. For these larger supplies two types of crib have been used, those rising above the water surface and briefly referred to as visible cribs, and those which are entirely below the surface, or submerged cribs. The general arrangement of the former class is shown in Fig. 1, which is broadly typical of this class, while Fig. 2 shows the submerged type of crib. Visible cribs are in use in Chicago, Cleveland and other places and are located in from 35 ft. to 50 ft. depth of water, the deeper water being the more preferred. Frequently they have no integral connection with the intake pipe, their main function being to protect the end of this pipe or tunnel from damage and to aid it in drawing a satisfactory supply.

Visible Cribs.—Visible cribs are always made high enough to prevent water washing over the top of them into the intake pipe, because surface water is not as satisfactory as that taken from lower down. As will be seen in Fig. 1, the crib consists of an annular ring of stone work of concrete filled inside with permanent timber or steel forms, the part above the water surface usually being of stonework or concrete of extra strong construction. The larger cribs are over 100 ft. diameter outside and rise as much as 20 ft. above the lake. Through the annular ring, ports are left through which the water enters, these ports being as near the bottom as possible, and yet not low enough to draw in material from the bed of the lake.

Cribs of this kind are very expensive to build and also to maintain, since lights must be kept on them during the season of navigation, and they be able to resist the effects of floating ice during the winter. It is the desire of their designers to keep them from drawing ice through the ports in winter, but this has always proved an exceedingly difficult matter and ice gives very serious trouble at times by blocking up the supply; some of the cribs

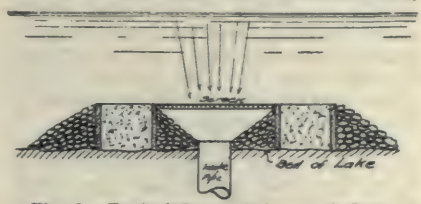


Fig. 2.—Typical Large Submerged Crib.

are equipped with large boilers to use in such an emergency. Ice is one of the greatest menaces, and even with cribs in deep water, with the ports well below the surface, ice is drawn down to them from the surface, due to too high a velocity of water through the ports since the draft of water to a port seems to be concen-

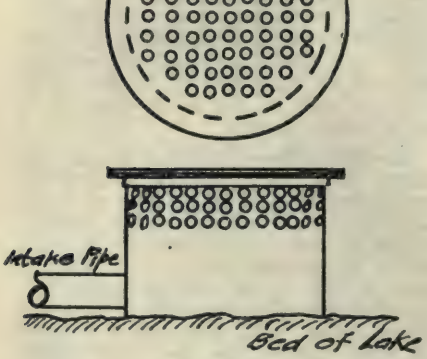


Fig. 3.—Strainer on Intake Pipe.

trated in a small cone. In this connection it should be pointed out that what is called the mean velocity through the ports, found by dividing the area of them into the volume of water, is always kept low so as to reduce the tendency to draw ice, but even if the average velocity of flow is low, and the distribution of the water through the port has not been properly adjusted, it may be found that the swiftest flowing part of the water entering the port will readily draw in ice that would not be affected by the water if it all moved at the same rate which would be equal to the average velocity.

Submerged Cribs. — Submerged cribs are now finding very much favor both for small and large supplies, and indeed, the cost prevents the use of anything else for the smaller quantities of water. The fact that Milwaukee and Cleveland have recently constructed cribs of this description is very interesting, even though the latter place already had its first crib of the visible type. Contrary to what might at first sight appear to be the case, the original cost of such a crib for a city like Cleveland would not be much less than that of the visible one, for in such cases the intake pipe takes the form of a tunnel, and in order that the outer end of this may be built, protection must be secured against rough seas. This necessitates the use of a visible crib during construction, and the upper part of the crib is afterward removed, leaving only the lower part as a protection to the finished intake. The annual cost of upkeep of submerged cribs is small for evident reasons. Both Toronto intakes are of this type. All such cribs have a tendency to draw from the surface to some extent the water coming down in a cone as suggested in Fig. 2, again causing a concentration of flow through a part of the screen.

For the smaller places the submerged crib is the only one practicable, and as these intakes usually consist of iron or steel pipe, laid on or just below the bed of the lake or river, the usual practice is to construct the main part of the crib on shore, tow it out to place and, after sinking, filling it with stones or concrete; the pipe is then connected to it by divers. In the design of such cribs one important problem is to keep out foreign matter from the intake, because there is no real isolation of surface water from the intake pipe as is evident from inspection of Fig. 2. The tendency for foreign matter to enter

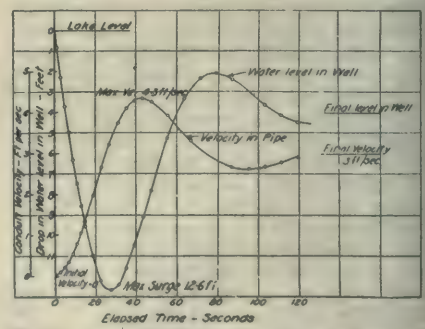


Fig. 4.—Surge Study—24 in. Intake, 2,000 ft. Long to a Well 4 ft. Diam. Sudden Demand from Rest of 9.42 C. F. S.

depends on the maximum velocity through the intake, and hence the draft of water must take place over a large area so as to prevent concentration. But in view of the fact that the axis of the intake pipe is frequently vertical where it passes into the crib, the flow is liable to be concentrated as already mentioned in re-

ferring to Fig. 2, and some form of protection must be devised which will keep substances from dropping directly into the intake, and the writer believes that both of the above features may be combined in a most satisfactory manner and to better advantage than is possible with the screen placed horizontally.

Screening the Water.—Most of the cribs put down some years ago were made in the form of "strainers" or had screens of a more or less perfect construction, so as to prevent fish or debris entering the intake pipe. One arrangement used was to perforate a few lengths of the intake pipe with holes about ¾ in. diameter, placed close together in the upper half of the pipe. Another plan was to have the intake terminate in a steel strainer of the general form shown in Fig. 3. In the writer's opinion such an arrangement is a mistake, because it forms a suitable means of starting anchor ice, which will block up the openings and close the intake, and again, it is always difficult to find the position of the intake strainer and to remove an obstruction in ordinary weather, and is impossible to do so in inclement weather. The openings to the intake should never be small and there does not seem to be any objection to having them 9 in. to 12 in., or even more if desired, in their smallest dimension, but if this construction is employed the velocity of the water should be the smallest where it first enters the crib and it should increase to a maximum in the pipe, so that whatever does enter the crib will proceed into a region of higher velocity and will thus be driven through the pipe with certainty.

Such a design necessitates the use of a screen-well on shore, through which the water must pass on its way to the pumps, and this well must be of ample size so that the velocity through it will be small. The well must contain screens, which may be removed for cleaning and which may be removed for cleaning and which should be fine enough to prevent any objectionable substance, such as fish, entering the pumps. To facilitate cleaning, duplicate screens should be provided so that one set may be drawn out for cleaning without leaving the pumps unprotected.

Intake Pipe.—The intake pipe should be amply large and laid to proper depth and grade. In regard to the size, it should be noted that the capacity of a pipe increases at a very much greater rate than its diameter, and also at a greater rate than its area, while it is roughly true that the initial cost of the pipe varies as its diameter. The following figures, based on similar pipes in all respects except size, will be instructive in this connection, and are only given to stress the point mentioned; they are only given to stress the point mentioned; they are based on velocities somewhat above 2 ft. per second in the smallest pipe.

Size pipe	Relative diameter	Relative area	Relative capacity
12 in.	1	1	1
16 in.	1.33	1.78	2.1
24 in.	2.00	4.00	6.2
36 in.	3.00	9.00	18.0

A glance at the table shows that a 16 in. pipe has a great advantage over a 12 in. pipe, in that its cost would only be about 33 per cent. higher, while it could carry twice the water, and the 36 in. pipe shows a similar fact in a more forcible way.

It is, therefore, good economy to make an intake pipe amply large, and this should be borne in mind very carefully.

One misfortune about too many intake pipes is that they do not slope upward all the way from the crib to the well, and, therefore, have pockets for air to collect, while another thing that is frequently neglected is to place the shore end deep enough. Should proper allowance not be made for the variation in lake levels, it may be found that an intake will have almost no capacity at times. Thus, the level of Lake Ontario has an extreme variation of approximately six feet, so that a 12 in. 1,200 ft. long, laid with the shore end at lowest water level, would have no capacity when the lake was at its lowest elevation, and a capacity of 1,330,000 gals. per day when at highest level. Such an intake is of no value under low water conditions, and low water may easily occur at a time when a large supply is demanded.

Surges in Intakes.—With further reference to the proper depth at which pipes should be laid, the writer had occasion to study the effect of surges in the pipe in this connection, and Fig. 4 is presented as an illustration, although the proportions there stated would be a clear indication of poor design.

The curve shows the case of a 24 in. intake pipe 2,000 ft. long supplying water to a 4 ft. well on shore. From this well the pumps draw water, and it was assumed in the problem that when the pumps were started they would instantly begin to deliver water at the rate of 9.42 cu. ft. per sec. or five million gallons per day. The curves show in a clear way how the velocity in the pipe gains its final value by first exceeding it, and then dropping back again, but the main point has to do with the water levels in the well and a history of them is also given. Assuming an amply deep well and sufficiently deep suction pipe, the intake pipe would have to be laid to a depth of 12.6 ft. below low water at the shore end, instead of the 4 ft. required for the steady flow, if it were desired to avoid possibility of the pipe emptying at the shore end. The size of well is a very material element in this last case and if the well has been made larger the water level would have fallen a much smaller distance, but the point made clear by the curve is that the size of well partly determines the depth at which the pipe should be laid, and that it should always be laid lower than is required to overcome friction losses.

The curves also are interesting in showing the type of phenomenon that occurs if the intake pipe is connected directly to the pumps, or if the pump suction pipe is very long.

Garbage and Refuse Disposal at New York City.—The Boroughs of Manhattan, Brooklyn and The Bronx of New York City produce daily approximately 9,000 tons of ashes, 900 tons of rubbish, 1,500 tons of garbage, and 1,000 tons of street sweepings. Garbage is dumped 20 miles southeast of Scotland Lightship, off Sandy Hook, at a cost of about 45 ct. per cubic yard, or 75 to 80 ct. per ton. The ashes, rubbish and sweepings are deposited in dumps, largely on Rikers Island, where the rubbish is burned, leaving a fairly solid fill.

Swimming Pools.—A bulletin devoted to the water supply for swimming pools has just been issued by the Graver Corporation, East Chicago, Ind. In addition to containing data on swimming pool design, construction and operation, the bulletin gives actual layouts of three installations.

Movement of Bacillus Coli in Ground Water With Resulting Pollution of Wells

Abstract of Report Presented May 17 to Conference of State Health Officers

By C. W. STILES and HARRY R. CROHURST

Professor of Zoology, Hygienic Laboratory, and Sanitary Engineer, U. S. Public Health Service

The pollution of the ground-water (or phreatic water) by privy wastes, and the possibility and method of extension of this pollution to wells, springs, and other water supplies, have been subjects of discussion, experiment, and public health legislation for many years and in various parts of the world; but the opinions the sanitarians have held on the general subject have been far from uniform, the results of experiments have been largely negative, and legislative policies have been distinctly contradictory.

Experiments of U. S. Public Health Service.—In connection with investigations by the U. S. Public Health Service into methods of disposal of privy wastes in rural districts, extensive and rigorously controlled experiments have been made which bear upon the subject at issue and especially upon the movement of bacteria, of fecal origin, in the ground-water. These studies have involved the experimental pollution of the ground-water (namely, the water in the saturated zone, which supplies wells and springs), have been correlated with the rise and fall of the ground-water table, the flow of ground-water, and the rainfall. Natural can material (human excreta from can type privies) was used as pollution material, Bacillus coli was taken as the bacterial test, and a dye (uranin) was utilized in tracing the movement of the water from the dosing trenches to the more than 400 experimental pipe wells which were arranged at intervals from the trenches and at various depths into ground-water.

The examination of thousands of water samples from the wells during a period of more than a year has resulted in very definite data which seem to express practically a natural law as applied to the movement of the bacteria in the field of fine sand

in which the experiments were conducted. The results to date may be summarized as follows:

Results of Experiments.—Pollution with fecal Bacillus coli has up to date been definitely and progressively followed in the ground-water for distances of 3, 6, 10, 15, 25, 35, 45, 50, 55, 60, and 65 ft. from the trench in which the pollution was placed; uranin has been recovered from these same wells and has spread to other wells at 70, 75, 80, 85, 90, 95, 100, 110, and 115 ft. from the pollution trench. The soil in question is a fine sand with an effective size of 0.13 mm.

2. The pollution has traveled these distances within a period of 187 days, or about 27 weeks, and only in the direction of the flow of the ground-water; no convincing evidence is present that the pollution has traveled against the flow of the ground-water or at right angles to it.

3. The pollution has traveled only in a thin sheet at the surface of the zone of saturation; there is no evidence at present that it has dispersed radially downward, and even when heavy pollution is recovered at the top, water from lower levels (in nearby deeper wells) is negative both for uranin and for B. coli.

4. As the ground-water level falls, owing to dry weather, the pollution tends to remain in the sand above the new (lower) ground-water level, namely, in the new capillary fringe.

5. There is no evidence which would justify a conclusion at present that either the bacteria or the uranin is carried or moves to any appreciable distance in the capillary fringe itself, and there is neither theoretical reason nor experimental evidence to justify a conclusion that either the bacteria or the uranin progresses in the dry, aerated intermediate belt (between the capillary fringe and the upper soil belt). All present evidence is to the effect that when the ground-water level falls the pollution remains practically stranded in the capillary fringe or in the intermediate belt—according to the degree of fall of the ground-water.

6. A rainfall of 1 in. results in a rise of 5 to 6 in. in the ground-water table (in the particular experimental area in question); and if this rise is sufficient to reestablish the zone of saturation up at the level of the stranded pollution, the bacteria and the uranin are again picked up and carried along farther in the direction of the ground-water flow until dry weather again intervenes to cause another fall of the ground-water level.

7. Thus the progressive (passive) movement and the stasis (stranding) of the pollution are intimately connected with, are dependent upon, and alternate with the rise and the fall of the ground-water level, and this latter factor is dependent upon the alternation of wet weather (rainfall) and dry weather (lack of rain at the intake area of the ground-water table). Experiments are now under way to determine, if possible, whether pollution placed directly into a deeper level of the ground-water will travel up to the surface of the saturated zone.

8. In explaining these results, capillarity, filtration, and gravity seem to come up for special consideration.

9. In one experiment the pollution traveled only 45 ft. from Sept., 1922, to May, 1923, and remained stranded at this distance. Study of the formation of the ground revealed that under the belt of pollution there is an impervious or nearly impervious stratum of peatlike material, which gradually tilts upward distally from the pollution pit and forms a ground-water dam; the pollution traveled out on high ground-water to the dam, the ground-water level fell below the crest of the dam, and the pollution is now stranded, pending a rise of the ground-water table sufficient to produce a ground-water cascade which will carry the pollution over the crest of the dam.

10. The ultimate distance to which the pollution will be carried is dependent upon a number of complex and interlocking factors, namely, wet and dry weather, with resulting rise and fall of the ground-water; the length of each of these periods; the rate of the ground-water flow (depending upon the "head," which, in turn, is dependent upon the rainfall); and, obviously, also the factor of the viability of the organisms under conditions of moisture, pH, food supply, etc., ad finem.

11. In another series of experiments human feces were buried in pits, in a locality of high ground-water, and covered with sawdust. Of five samples taken three years and two months after burial all were both macroscopically and microscopically

recognizable as feces, but the odor had become somewhat musty; three of these samples were positive and two were negative for Bacillus coli; ova of Ascaris lumbricoides were recognizable in all five samples, but all 57 ova found were dead.

12. The bearing of the foregoing results upon the intermittent pollution of wells, the location of water supplies, and the location of camps in peace or in war, will be evident to persons who are called upon for technical advice in these matters; the justification of the laws forbidding the use of abandoned wells for the disposal of excreta is self-evident; the possible effect of the custom (in some localities) of digging pits into ground-water (as advised by some persons) is obvious.

13. In protecting wells, special attention should be given not only to surface protection as is now generally recognized but also to a new element, namely, the danger zone which exists from the highest water level to about a foot below the lowest water level. A leak in the pipe in this region is potentialy very dangerous, and all wells unprotected in this danger zone are to be considered as potentially unsafe.

Effect of Size of Filter Sand on Operation

Comparison of Performance of Individual Filters Given at Ohio Conference on Water Purification

By E. E. SMITH, 2ND
Superintendent of Filtration, Lima, O.

The six units at the Lima filtration plant have separate outlets to the clearwell, so that it has been customary to collect separate samples at times of general sample collection for plant control, using the average bacterial count from separate plates as the estimate for filtered water prior to disinfection. During the year 1921, all bacterial counts were made with an incubation temperature of 37° C.; during the year 1922 a change was made to an incubation temperature of 20° C., all counts being made with "Standard Methods" agar. Exact measurement of initial and final loss of head have been made and other engineering data have been collected, the summaries of which are herewith presented. The mechanical analyses of sand samples were made at the laboratory of the State Department of Health in December, 1921.

The filters may be divided into two groups according to differences in physical characteristics of the filter sand. Filters 1, 3, and 5, located on the west side of the filter gallery have a sand of smaller size and greater uniformity than filters 2, 4, and 6, on the east side. Those filters having the finer and more uniform sand also have a slightly thinner sand layer, or at least a greater distance between the sand line and the tops of the wash-water troughs. During the two years' observations the rate of washing has been uniformly the same—24 to 25 in. rise of wash water—applied for one minute at a low rate, then the remainder of the recorded time of wash at full opening of the wash water valve. The time of wash has been fixed to maintain as nearly as possible the same volume of wash water passing through the filter at each wash.

A study of the figures recorded shows that the filters with the finer sand require approximately one-half minute longer to pass the same quantity of wash water; they have consistently higher initial loss-of-head; and always shorter runs, requiring higher percentages of total wash water. The figures for bacterial removals do not indicate any such consistent differences, but show practically the same removals. For the two periods the removal of B. Coli has been practically the same,—93 per cent.

All of the filters show sand of size and uniformity falling within the limits suggested by Mr. Dittoe in November, 1921,—less than 0.45 mm. During 1922, the filters were allowed to reach a final loss-of-head of approximately 8.5 ft., while in 1921 they were permitted to reach the practical limits of loss-of-head,—11 feet; and the total percentages of wash-water for the two periods,—4.1 for 1922 and 2.8 for 1921—result from such change in operation. Other conditions have also caused the increase in percentage; namely, poor coagulation in cold weather, filter growths in warm weather, as well as the attempt to consistently produce a filter effluent below a confirmed B. Coli index of 2 per 100 cc.

Filter runs for those filters with the coarser sand were approximately

Table I—Description of Filters

Filter number	1	3	5	2	4	6	1,3,5	2,4,6
Effective size (mm.)	0.37	0.37	0.38	0.44	0.42	0.42	0.37	0.43
Uniformity coefficient	1.22	1.27	1.21	1.36	1.38	1.43	1.23	1.39
Distance of top of sand to top of trough (in.)	29.62	29.88	29.75	28.38	27.00	29.00	29.75	28.15

Table II—Comparison of Performance of Filters as Measured by 37° C. Bacterial Count, Year 1921

Filter number	1	3	5	2	4	6	1,3,5	2,4,6
Filter efficiency (bacterial removal)	81%	81%	82%	77%	77%	80%	81%	78%
Average wash water used (gals.)	28,900	28,900	28,500	28,800	28,100	28,500	28,800	28,500
Time of wash (minutes)	4:40	4:34	4:51	4:12	4:15	4:11	4:42	4:13
Length of run (hours)	25:00	22:44	25:50	30:46	30:10	30:21	24:31	30:26
Initial L-of-H (ft.)	1.45	1.27	1.38	1.23	1.12	1.35	1.37	1.23
Final L-of-H (ft.)	11.00	11.10	11.00	10.90	10.90	11.10	11.03	10.97

Table III—Comparison of Performance of Filters as Measured by 20° C. Bacterial Count, (Jan.-Oct., 1922)

Filter number	1	3	5	2	4	6	1,3,5	2,4,6
Filter efficiency (bacterial removal)	64%	59%	72%	69%	68%	71%	65%	69%
Average wash water used (gals.)	26,100	25,300	26,100	25,400	24,800	25,500	25,800	25,200
Time of wash (minutes)	4:26	4:05	4:18	3:41	3:40	3:48	4:12	3:43
Length of run (hours)	16:00	14:29	15:07	18:32	19:24	18:01	15:13	18:39
Initial L-of-H (ft.)	1.44	1.35	1.59	1.32	1.21	1.52	1.46	1.35
Final L-of-H (ft.)	8.46	8.53	8.45	8.36	8.50	8.47	8.48	8.44

24 per cent longer than those with the finer sand. Had all filters been equipped with filter sand of 0.43 mm. effective size, it is probable that the average percentage of washwater would have been reduced possibly half of this difference, or instead of 2.8 for 1921 it might have been 2.5 per cent, and instead of 4.1 for 1922 it might have been 3.6 per cent. Although these conclusions are based upon small differences in size of filter sand, they are also based upon many observations. They serve to indicate that small differences in size of sand are important, and that careful attention to size and grading of filter sand may have far-reaching results in operation.

Expressing Results of Water Analyses

Graphic Scheme Described at Ohio Conference on Water Purification

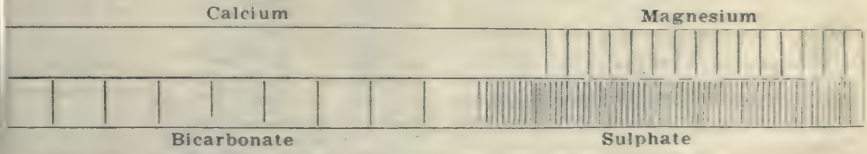
By C. P. HOOVER

Chemist in Charge Columbus, O., Water Purification and Softening Works

The routine determinations made at Columbus to determine the proper treatment of the water are (1) total alkalinity, (2) phenolphthalein alkalinity, (3) caustic alkalinity, (4) incrustants, (5) total hardness, (6) magnesium and (7) calcium. These tests are satisfactory for routine purposes, but are not as adequate for studying water softening reactions as a graphic scheme recently explained by Mr. W. D. Collins, Chief of the Quality of Water Division of the U. S. Geological Survey.

The scheme consists in dividing the parts per million of each radical shown in the analysis by the combining weight of such radical. The result gives an arbitrary figure, which, for the purpose of plotting, may be called inches or spaces on section paper. The combining weight of any element is obtained by dividing the atomic weight by the valence. Tables are herewith given showing how combining weights or equivalents of elements and compounds determined in water analyses are computed.

The hypothetical combinations are based on the theory that the total alkalinity should first be calculated to calcium. If the carbonates exceed the necessary amount of calcium, the rest of the alkalinity may be calculated to magnesium carbonate; and sulphates, chlorides, etc., combined with magnesium until the latter is



Graphic Scheme for Expressing Results of Water Analyses

Table I.—Combining Weights Computed

Element or Compound	Atomic Weight	Valence	Combining Weight or Equivalent
Calcium	40	2	20
Magnesium	24	2	12
Sodium	23	1	23
HCO_3*	61	1	61
Sulphates (SO_4)	96	2	48
Chlorine	35	1	35

*HCO_3 is obtained from the alkalinity by multiplying by 1.22. (See Standard Methods of Water Analyses, page 38.)

Table II.—Example from Actual Experience in the Analysis of Scioto River Water at Columbus, Ohio

Calcium	96	divided by 20 = 4.8
Magnesium	35	divided by 12 = 2.9
Alkalinity	200x1.22	divided by 61 = 4.2
Sulphate (SO_4)	168	divided by 48 = 3.5

exhausted. But if the calcium exceeds the amount necessary to take care of the alkalinity there is no magnesium carbonate, and the excess of calcium may then be calculated to sulphate first, then chlorides and nitrates until exhausted; and the magnesium is combined with the remaining acid radicals until exhausted. Any remaining chlorides, nitrates or sulphates may be calculated to sodium and potassium salts.

Municipal Use of Water at Springfield, Mass.

The total municipal use of water in 1922 at Springfield, Mass., was valued at $71,027, according to the 49th annual report of the water commissioners. The report states:

The following tabulation in customary form shows the consumption of water during the year past by the various municipal departments of the city, with its prescribed values, or accrued earnings to the water works from same, as properly credited on its books. This amount is annually entered on the water works books and charged off as uncollectible in accordance with the provisions of city ordinance.

Classification.	Amounts.	Gallons.	Memo.
Schools	$ 8,335.80	125,037,000	92% metered
Public buildings (other than schools)	2,931.85	43,977,750	90.2% metered
Public parks	2,808.15	42,122,250	67.8% metered
Public playgrounds	452.95	6,794,250	4.8% metered
Building purposes (Streets and Engineering Department)	286.80	4,302,000	Unmetered
Sewer Department (flushing)	2,578.60	38,679,000	Unmetered
Snow removal (via sewers)	1,301.33	19,520,000	Metered
Street washing and sprinkling	1,481.86	22,228,000	Unmetered
Total of above	$20,177.34	302,660,250	
Fire hydrant service	50,850.00	(Not reducible to quantities)	At $25 per hydrant.

Municipal Use of Water—1922.—Unmetered quantities in gallons are estimated from amounts on basis of 6 2/3 ct. per 1,000 gal., or equivalent to 5 ct. per 100 cu. ft.

Water Works for Malaga, Spain.—The municipality of Malaga, Spain, is preparing for a large bond issue to improve the municipal water works system. It is stated that a Spanish bank will probably take the bonds and that the contract will probably go to Spanish firms.

Water Works in Kansas.—Practically 50 per cent of the 542 incorporated cities of Kansas have water systems. Of 261 systems 255 are owned and operated by the municipality.

Federal Investigations for Reclamation Projects.—Plans for the expenditure of $225,000 appropriated by Congress for the fiscal year 1924 to investigate possible reclamation projects in Western states have been made public by the Secretary of the Interior. The money will be used to examine into reclamation areas in 11 Western states and cover some 18 proposed projects.

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Railways

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.

221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*

LEWIS S. LOUER, *Vice-President and General Manager*

New York Office: 904 Longacre Bldg., 42d St. and Broadway

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Vol. LX. CHICAGO, ILL., JULY 18, 1923 No. 1

What Is Wrong With the Interstate Commerce Commission?

For 17 years the Interstate Commerce Commission has had regulatory power over railway rates. During that period investments in railway stocks have become less and less attractive. The present market value of all railway securities has been estimated at $13,000,000,000, although the I. C. C. itself estimates that the actual investment in the railway plant is fully $19,000,000,000. The common stock of many of the leading railway systems is selling at a small fraction of its par value, and the par value is less than the actual investment. Consider Rock Island selling at $25 a share when its par value is $100, and when the I. C. C.'s appraisal at original costs (not at reproduction costs) less depreciation shows that the capitalization is less than the appraised value! Consider New York, New Haven and Hartford at $10 a share, under conditions corresponding to those just named for the Rock Island. Glance down the stock market report column any day and ask yourself why railway stocks that were once gilt-edged are now fray-edged. Ponder the fact that no new railway common stock issued for extensions or improvements is salable at all.

Political attacks upon railway rates are primarily responsible for this state of affairs, and the I. C. C. has been, in the main, a political tool. Its members have been politicians, for the most part, trained to listen to the voice of the people. Since it is always popular to reduce passenger and freight rates, the I. C. C. has usually favored rate reduction.

There never will be satisfactory regulation of railway rates until the members of the Interstate Commerce Commission are as free from political influence as are members of the U. S. Supreme Court. That is the first essential, and it seems to involve at least three things: First, appointment of professionally skilled men in-

stead of politicians. Second, long tenure of office. Third, liberal salaries.

Doubtless we are biased in favor of engineers, but it is our belief that the majority of the members of the I. C. C. should be engineers who have had broad executive and economic experience. Such men as Herbert Hoover, Gen. George Goethals, Eugene G. Grace (president of the Bethlehem Steel Co.), John Hays Hammond and Samuel Rea (president of the Pennsylvania Ry.)

The members of the Interstate Commerce Commission should be completely insulated from the fire of popular prejudice and from the ice of public disapproval. Their's should be the task of being wisely fair in railway regulation, without fear of criticism or of loss of position if their decisions prove to be temporarily objectionable to any "bloc" in Congress or any selfish coterie elsewhere.

Shall Original Cost or Present Value Be the Base for Rates?

In a decision handed down May 21, the U. S. Supreme Court again rules that the rates charged by public utility companies must be based on present costs. In the Southwestern Bell Telephone case the Supreme Court of Missouri had supported a decision of the Public Service Commission of Missouri, in which the original cost of the plant, $20,000,000, had been used as the rate base. The U. S. Supreme Court reversed this decision, saying:

"Obviously, the Commission undertook to value the property without according any weight to the greatly enhanced costs of material, labor, supplies, etc., over those prevailing in 1913, 1914 and 1916. As matter of common knowledge, these increases were large. Competent witnesses estimated them as 45 to 50 per centum.

"It is impossible to ascertain what will amount to a fair return upon properties devoted to public service without giving consideration to the cost of labor, supplies, etc., at the time the investigation is made. An honest and intelligent forecast of probable future values made upon a view of all the relevant circumstances, is essential. If the highly important elements of present costs is wholly disregarded such a forecast becomes impossible. Estimates for tomorrow cannot ignore prices of today.

Witnesses for the Company asserted —and there was no substantial evidence to the contrary—that excluding cost of establishing the business the property was worth at least 25 per cent more than the Commission's estimates, and we think the proof shows that for the purposes of the present case the valuation should be at least $25,000,000."

This 25 per cent added to the original cost by the U. S. Supreme Court is a net increase after deducting depreciation.

Seven of the nine judges concurred in the entire opinion, but two dissented as to the rate base. Justices Brandeis and Holmes held that the rate base should be the "prudent investment." Justice Brandeis' main argument for original cost is founded upon the expedience and justice of establishing once and for all a rate base that not only will not shift with every change of prices or wages, but also one that is not a matter of judgment or opinion but of fact. His argument is quite convincing if sight is lost of the fact that if the purchasing power of a dollar changes there is no stability in the "real" income even where the rate base is stabilized. It is curious to note that although Justice Brandeis argues soundly for stability of income, he always speaks in terms of money income and never in terms of "real" income, namely the goods and services that money will buy. The investors in German bonds have had a stablized money income, but a worthless "real" income. It is our belief that the U. S. Supreme Court decisions in favor of reproduction cost, less depreciation as a base for rates give a far closer approximation to stability in "real" income than would exist were original cost used as the rate base.

The 5ct Fare in Seattle

Editorial in A. E. R. A.

Now Mayor Brown of Seattle says that "it has been proved that the 5-cent fare is not practical under present conditions" in Seattle. He said that after he had vetoed an ordinance restoring the 10-cent fare when the 5-cent fare was causing a deficit of about $4,775 a day; when the city was not getting enough money out of the municipal railway to pay its operating expenses; when the railways had

taken to issuing warrants instead of paying cash.

What made him change his mind? The fact that the banks would not honor the warrants, the banks knowing that a continuation of losses such as were piling up would bring about a chaotic financial situation. There was not enough money to pay the trainmen's wages, so the mayor signed a new ordinance restoring the 10-cent fare on June 15.

All that Seattle has as a result of its political manipulation of the municipal street car system is a loss of some $500,000 during the 107 days the 5-cent fare was played with. This money must be obtained from future earnings of the system—a burden that well might have been avoided if the street car fares had not been made a political football.

If any sane person needed additional proof that municipal ownership, demagogy and financial disaster go hand in hand, this latest development in Seattle furnishes it.

How To Deal With the Railroads

Editorial in Chicago Tribune.

Recently a conference on railroads was held in Chicago. It was dominated by the politics which finds it profit in attacks upon the railroads and which asserts drastic conclusions on an assumed knowledge of conditions in which fair and conservative minds have little confidence.

We are now hearing from a conference of a very different character—namely: that of the American Society of Civil Engineers. Its attendance is composed of men who can find no profit in political assumptions, who are not fishing for votes, whose training is expert, whose method of reasoning is exact, whose object is the ascertainment of facts and the establishment of principles which are sound and conducive to public benefit.

The discussion and conclusion of such a gathering deserves the respectful and thorough consideration of the public and that of the representatives of public interest in every legislative body which proposes to deal with the problem of regulation of transportation agencies. The American people will be wise to prefer the advice of such men to that of politicians whose main interest is to exploit evils rather than to correct them. The engineers' interest is to perfect our transportation, not to ride into office by attacking its imperfections or alleged imperfections. Their interest, in other words, is that of the public.

There is no more important interest in our public life. Transportation, especially by rail, is the arterial system of the country, and the health of that system is vital to our prosperity and growth. There is nothing which could deal a deadlier blow at the welfare of us all, from the poorest to the richest, than blundering treatment of transportation; treatment born of lack of knowledge, of prejudice fomented by selfish politics, of imperfections and evils misunderstood and diagnosed unwisely. The effects of such treatment would reach into every home and into every occupation. It would hurt the farmer, the mechanic, the business man, the producer, and the consumer.

There is, therefore, nothing more important than that the problems of the railroads should be worked out on a plane of knowledge, justice, and sound judgment, and not in an atmosphere of prejudice and narrow self-interest. A leading speaker at the engineers' conference states the key of the situation when he says that "the successful solution of the railroad problem will depend upon scientific research to the end that essential engineering, accounting and economic data shall be determined, analyzed and presented to the interestate commerce commission."

We would add one other essential—namely: that scientific judgment shall govern, not prejudice fomented for political ends. It will not govern unless public opinion resists appeals to prejudice and keeps clear in its determination to know that truth and to support only such action as is fundamentally just to all interests involved and which is constructive in the development and maintenance of the most efficient transportation.

Cost of Automobile Operation at Salt Lake City.—During 1920 the City Engineer's Department of Salt Lake City, Utah, in connection with the work operated five automobiles. The average mileage per car was 7,587, at an average gasoline consumption of 14.4 miles per gallon. The total cost per mile was 7½ ct., made up of a labor cost of 2.3 ct., and a maintenance cost of 5.2 ct.

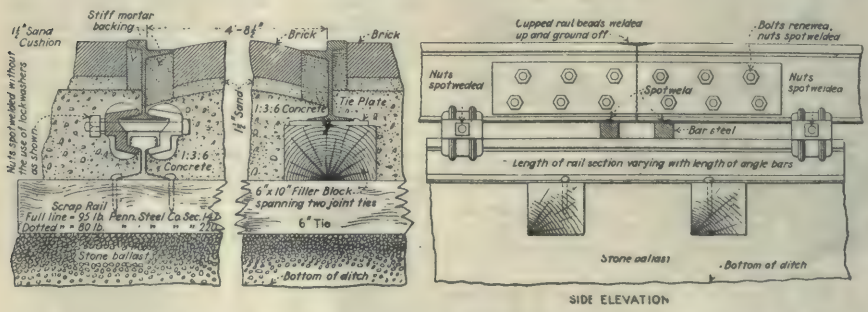
Method of Boosting Rail Joints

A modification of the plan of placing a length of rail underneath the joint and connecting it at the ends of the angle bars by clips, so as to permit the driving of steel bars underneath the joint to boost it, is used by the Lehigh Valley Transit Co., Allentown, Pa. The method is described in the Electric Railway Journal from which the matter following is taken.

This plan was used with an inverted rail, without supporting ties, the old ties having been cut out at approximately the center line of the track and the bracing rail, clips, etc., imbedded in a dry concrete to a depth of some 6 in. below the bracing rail. Good results have thus been secured for individual joint repairs where extensive rehabilitation of tracks was not made.

Where an extensive stretch of track was entirely rehabilitated, a supporting tie construction was preferred. Where the rail was found to promise from 5 to 6 years longer life, the expense of installing new crossties and a filler block under the rail opposite the joint was thus considered advisable. The accompanying line cut shows this type of construction. The bracing rail is placed with the head side uppermost, of such a length that the repair clips can be placed just outside the end of the angle bar.

A 6-in. x 10-in. filler block, long enough to span two joint ties, is used on the opposite rail, and crossties are installed underneath the entire construction. Stone ballast to a depth of 6 in. is used underneath these crossties. After the joint had been boosted by driving in the supporting steel bars, these are spot welded to prevent shifting. The bolts of the angle bars are renewed and the nuts, together with those on the clips, are spot welded. No lock washers are used. Cupped rail heads are welded and ground off to complete the joint.



Joint Repairs with Bracing Rail Supported on Ties and Fastened to Operating Rail by Cast Steel Clips.

The Deepest Mine in the World

In a paper presented May 3 before the New York Section of the American Institute of Mining and Metallurgical Engineers, Thomas T. Read, Supervising Engineer, U. S. Bureau of Mines, gave the following information regarding deep mines:

The St. John del Rey mine, in Brazil, has reached a vertical depth of 6,726 ft. below the top of its shaft; miners enter it, however, through an adit which intersects the shaft 324 ft. below its top, wherefore it might be said that the mine is really only 6,400 ft. deep. In the Kolar gold field of India there are a number of deep shafts, one of which reaches to a vertical depth of 6,140 ft. below surface. In South Africa also there are a number of deep shafts, the Village Deep being 6,100 ft. early in 1921. The City Deep, Ltd., proposes to sink to a depth of 7,000 ft. but presumably by the time it does so the St. John del Rey will be deeper than that, since it has been increasing in depth at an average of about 150 ft. per year. The deepest shaft in the United States, the Tamarack No. 5, although it is only 5,308 ft. deep, actually approaches nearer to the center of the earth (4,100 ft below sea level, as against 3,958 ft. at St. John del Rey.) The deepest workings in the Calumet & Hecla go down to 4,600 ft. below sea level.

Improved Type of Steam Roller Wheel

Used in Paving Department of the Pacific Electric Railway Co.

By CLIFFORD A. ELLIOTT,
Engineering Department, Pacific Electric Ry.

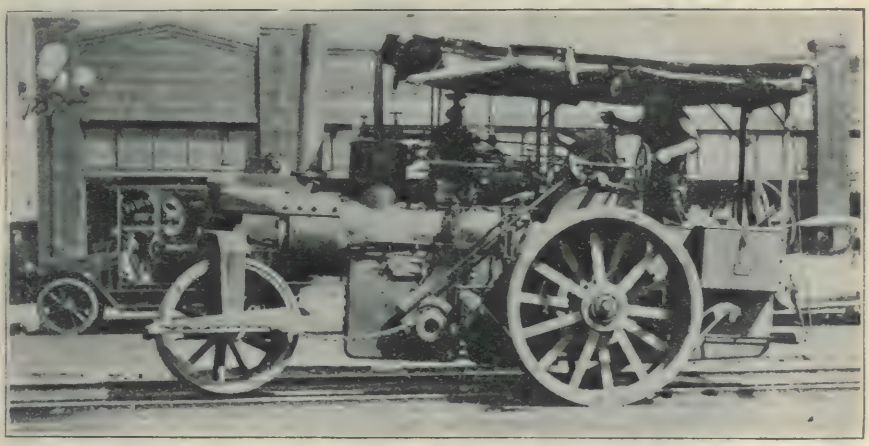
For some years the maintenance of wheels on the steam rollers used in the paving work handled by the Engineering Department of the Pacific Electric Railway Co., Los Angeles, Calif., has been quite a problem.

The wear and tear on the wheels when coming in frequent contact with the rails of the tracks, striking the granite blocks and running over special work layouts, has been quite noticeable. In the past the wheels were usually renewed by securing them from eastern manufacturers or by having them repaired in local foundries. The old type of wheel has always been renewed in kind as to class of metal and design; that is, only one pattern was used, wheels were fabricated of cast iron and a thickness of 2-in. rim obtained as existed on old type of wheel. Also when molded at foundry only one molding was made for the fabrication of an entire wheel.

The main fault of the old type wheel was in the class of metal and the thickness of the rim. Hard usage of the steam rollers around the rails caused the thin metal to wear away and niche out at times, thus providing an uneven surface on the roller wheel, with consequent poorly rolled pavement.

After considerable study and experience in repairing the old type wheels, it was found more economical, as well as in interest of efficient work, to design in the Engineering Department an improved-type of wheel, thus overcoming the difficulties experienced in the past. The plans called for the rim to be 4½ in. thick as compared with old thickness of 2 in.

In adding more thickness and weight in metal to the new type of wheels it was essential to reinforce the hubs and spokes of the wheels. In the front wheels the old wheels had 8 spokes, while the new have ten. While the two rear wheels each had 12 spokes in the old type; and in the new 14 spokes are provided for each wheel.



Steam Roller With New Type Wheel Used By Paving Department of Pacific Electric Ry. Co.

The rollers equipped with the new type of wheels are 10-ton Monarch 3-wheel steam rollers. The new wheels are fabricated out of 40 per cent aluminum steel and 60 per cent Roman pig iron, which has proved more durable than the old style of cast iron wheels. In designing these wheels the plans call for two patterns, which naturally requires two moldings.

The specifications require that the foundry first mold the rim of the new wheels; then after molding the rims they are laid in the pig bed for two to three days. Later the newly-molded rims are placed on a lathe and the face of the rim is planed down, leaving a smooth and uniform bearing surface.

The second molding involves the hubs, which are molded separate from the rims.

In having roller wheels made during former years it was found that a

very unsatisfactory job was accomplished by casting the wheels under one pattern at the foundry, as non-uniform results were always obtained especially in the molding of the hubs, as the expansion in the hubs and spokes when molded in one casting with the rim did not satisfactorily retain so that the spokes would obtain the true position as called for in the plans, nor give the proper support to the wheel. In reality it resulted in an unbalanced wheel. Under the new plans, this new wheel is practically true in all its parts, due to the separate members being molded independent of each other.

How To Avoid Railroad Crossing Accidents

Supreme Court Justice Charles C. Van Kirk, of the Appellate Division of the Supreme Court, of the State of New York, sitting in the Third Department, has just pointed out in clear, unmistakable language in one of his opinions how motorists can avoid railroad crossing accidents with their inevitable death toll.

In this opinion, which is regarded by railroad men as worthy of wide circulation among motorists, Justice Van Kirk said: "The safe limit to speed in approaching a crossing is that speed at which the driver of an automobile, as he arrives at a point where he can see an on-coming train, when it is near enough to render crossing ahead dangerous, can stop his car if necessary before he reaches the track. It is futile to look when one cannot see. If he cannot see without stopping he must stop."

The language of the opinion handed down by Justice Van Kirk was in the case of James W. Horton versus the New York Central Railroad; the outgrowth of a railroad crossing accident, in which the Appellate Division reversed a judgment obtained by the plaintiff and dismissed the complaint against the railroad company.

The case presented to the Appellate Division and the elements that usually are brought forth in a crossing accident. The motorist killed was driving over the state road in an automobile and was struck by a train on a grade crossing. There were warning signs on the highway approaching the crossing, and the controversy taken on appeal centered on the interpretation of Section 53A of the railroad law in relation to these signs.

In his decision Justice Van Kirk said:

"A new vehicle has come into general use, which has occupied our highways to the exclusion almost of horse-drawn vehicles. Not only are more people exposed to danger because many more now travel on highways, but because those riding in trains likewise are put in jeopardy by the motor car; an automobile often carries five or six persons rather than one or two, a bus may carry a dozen and a train often carries scores.

"Because of its weight, its momentum, its inertia, its strong metal construction and its speed it wrecks trains. On the other hand when properly driven and maintained in good condition, it is under complete control; it may be stopped or started at will; it will stand without hitching and may be safely left unattended; it will not take fright at a train, however close to its nose."

Having distinctly pointed out that the automobiles as a machine has no responsibility for accidents, the Justice continuing in his opinion holds the driver to his responsibilities saying:

"Having provided for a disc sign and how and by whom it shall be placed the statute in perempty language provides 'It shall be the duty of the driver of any vehicle using such a street or highway and crossing to reduce speed to a safe limit upon passing such sign and to proceed cautiously and carefully with the vehicle under complete control."

"It is our view" continues the opinion "that if the drivers of automobiles obey this statute to its letter and its intent, seldom if ever will injuries be suffered at grade crossings. The price of safety by obendience to this statute means no more than three or four seconds of time—a small price for a life and in any event we believe the legislature was more interested in preserving life and limb than in preserving the right to recover damages for life and limb lost."

Towing Canal Barges With Tractors

The substitution of an American tractor for the barge horses commonly used in towing has been successfully carried out at Colwick, near Nottingham, England. A tractor weighing a little over a ton was used for hauling a loaded gravel barge with a total tonnage of 80 tons for a distance of about 3 miles. The trip was completed in 55 minutes. This method

of hauling a barge is quite unique in the United Kingdom and was adopted by the Trent Concrete Co. The experiment was quite successful, as the tractor was able to make five round trips a day, compared with about 2½ trips made with 3 horses towing one barge, thus practically doubling the capacity of the old system.

Blasting to Loosen Up Material for Suction Dredging

Dynamite was effectively used recently at the city of Kissimmee, Fla., where a dredge had been engaged to pump material from the bed of Lake Tohopekaliga to fill in back of a bulkhead, and make ground which it is intended to use for park purposes. The ground in back of the bulkhead was a marsh of some 7 or 8 acres which had to be raised from 1 to 5 ft., according to grade, with material pumped from the lake. The bottom of the lake consisted of heavy clay and marl, and was so stiff that unsatisfactory progress was being made until Otho O'B. Strayer, a dynamite expert of the duPont Company, was consulted, and he advised breaking the hardpan with dynamite and thus making it easy to get at the lower strata in the lake bottom. Under Mr. Strayer's directions, two rows of holes —20 holes in all—the rows 6 ft. apart and the holes spaced 10 ft. apart, were put down and loaded with 2½ lb. of 50 per cent straight dynamite each. The holes were put in from a pontoon and a 4 in. casing was used as a guide for hose nozzle and for loading purposes. The work had to be done through water from 2 to 4 ft. deep. The blast was a complete success, and reports show that after the use of the explosive, the dredge pumped out more material in the same length of time than it had ever handled prior to blasting and with half as much power.

A 375,000 H. P. Hydro-electric Development in Latvia.—Reports from Latvia state that the cabinet has allocated large sums for the building of hydro-electric stations on the River Dvina. It is said that the total available power at four sites is 375,000 H. P.

Mine Fatalities Due to Explosives

Mine fatalities due to explosives during the past 11 years have caused 2.6 to 5.9 per cent of all fatalities at bituminous coal mines, 4.1 to 8.9 per cent at anthracite mines, 9.3 to 14.2 per cent at metal mines, and 13.6 to 26.6 per cent at quarries, according to figures prepared by W. W. Adams, mine accident statistician, Bureau of Mines, Department of the Interior. No data are available regarding nonfatal accidents at coal mines, but the record shows that only 1.1 to 2 per cent of all injuries at metal mines and from 1.7 to 6.3 per cent of those at quarries have been due to the use of explosives. For every fatality due to explosives since 1911, there have been 7.5 nonfatal injuries at metal mines and 8 nonfatal injuries at quarries. A study of fatalities to underground employes at coal mines since 1911 (omitting 1919) shows that 37 to 61 per cent of the fatalities occurred at the anthracite mines in Pennsylvania which have produced from 14 to 18 per cent of the coal tonnage of the United States. The anthracite mines normally consume from 52 to 67 per cent of all dynamite and other high explosives used at the coal mines in this country, 21 to 31 per cent of all permissible explosives, and 11 to 17 per cent of all black blasting powder. In 1919 the number of fatalities at anthracite mines was abnormally high (149, or 72 per cent), due to a powder explosion in Baltimore Tunnel No. 2, at WilkesBarre, on June 5, which caused the death of 92 men.

Locomotive Shipments

The U. S. Department of Commerce announces May shipments of railroad locomotives from the principal manufacturing plants, based on reports reecived by the Bureau of the Census from the individual establishments.

The following table compares the May, 1923, figures with the previous month and with the corresponding month last year.

	May 1923	April 1923	May 1922
Shipments:			
Domestic	228	201	54
Foreign	10	16	16
Total	238	217	70
Unfilled orders: (end of month)			
Domestic	2,045	2,111	497
Foreign	105	93	124
Total	2,150	2,204	621

Current Material Prices

Iron and Steel Prices

(From the Iron Age, July 5, 1923)

Prices as of July 2, f. o. b. Pittsburgh:

Open hearth rails, heavy, per gross, ton	$43.00
Light rails (25-45 lb. section), per lb.	2.25
Track spikes, 9/16 in. and larger base, per 100 lb.	$3.15 to 3.25
Track spikes, ½ in., 7/16 in. and ⅜ in., 100 lb.	$3.25 to 3.75
Track spikes, 5/16 in.	3.75
Spikes, boat and barge, base, per 100 lb.	$3.50 to 3.75
Track bolts, ¾ in. and larger, base, per 100 lb.	$4.00 to 4.50
Track bolts, ½ in. and ⅝ in., base, per 100 lb.	$4.25 to 5.50
Tie plates, per 100 lb.	2.55 to 2.60
Angle bars, base, per lb.	2.75

Finished Iron and Steel

	Per lb. to large buyers. Cents
Iron bars, Philadelphia	2.72
Iron bars, Chicago	2.50
Steel bars, Pittsburgh	2.40
Steel bars, Chicago	2.60
Steel bars, New York	2.74
Tank plates, Pittsburgh	2.50
Tank plates, Chicago	2.80
Tank plates, New York	2.84
Beams, Pittsburgh	2.50
Beams, Chicago	2.70
Beams, New York	2.84
Steel hoops, Pittsburgh	3.30

Freight Rates

All rail freight rates from Pittsburgh on domestic shipments of finished iron and steel products, in carload lots, to points named, per 100 lb., are as follows:

Philadelphia	$0.325
Baltimore	0.315
New York	0.34
Boston	0.365
Buffalo	0.26
Cleveland	0.21
Cleveland, Youngstown, comb.	0.19
Detroit	0.29
Cincinnati	0.29
Indianapolis	0.31
Chicago	0.34
St. Louis	0.43
Kansas City	0.735
Kansas City (pipe)	0.705
St. Paul	0.60
Omaha	0.735
Omaha (pipe)	0.705
Denver	1.27
Denver (pipe)	1.215
Pacific Coast	1.50
Pacific Coast, ship plates	1.20
Birmingham	0.69
Memphis	0.385
Jacksonville, all rail	0.50
Jacksonville, rail and water	0.415
New Orleans	0.515

Rails and Track Supplies at Chicago

Standard Bessemer and open-hearth rails, $43; light rails, rolled steel, 2.25c, f. o. b. makers' mills.

Standard railroad spikes, 3.25c mill track bolts with square nuts, 4.25c mill; iron tie plates, 2.85c steel tie plates, 2.60c, f. o. b. mill; angle bars, 2.75c, f. o. b. mill.

Jobbers quote standard spikes out of warehouse at 3.90c base and track bolts, 4.90c base.

Cement Prices

Recent quotations, per bbl., in carload lots, exclusive of package:

Pittsburgh	$2.24
Cincinnati	2.54
Detroit	2.47
Chicago	2.20
Milwaukee	2.37
Duluth	2.14
Minneapolis	2.39
Davenport, Ia.	2.43

Cross Tie and Lumber Prices

(From Lumber, July 6, 1923)

White Oak Ties

F. o. b. cars, Chicago, July 3.

No. 5—7x9x8	$1.85
No. 3—6x8x8	1.55
No. 1—6x6x8	1.35
No. 4—7x8x8	1.75
No. 2—6x7x8	1.45

Red oak ties, 10@15c less than white oak. Sap pine and sap cypress, 10c less than red oak.

White oak switch-ties, per M. ft.	$55 to $58
Red Oak switch-ties, per M. ft.	49 to 51

White Oak Ties

F. o. b. cars, St. Louis, July 5.

No. 5—7x9x8	$1.65
No. 4—7x8x8	1.45
No. 3—6x8x8	1.35
No. 2—6x7x8	1.25
No. 1—6x6x8	1.15

Red oak ties, 10c per tie less than white oak prices. Heart pine and heart cypress, same prices as red oak. Sap pine and sap cypress, 25c less than white oak.

White oak switch ties, per M. ft.	$48.00
Red oak switch ties, per M. ft.	45.00

Bridge and crossing plank, same prices as switch ties.

Market Prices of Lumber

	Flooring, 1x4, No. 1 common	2x4, 16 ft., No. 1 common	Timbers, 6x6	Timbers, 12x12
Boston—Yel. Pine	.....	.....	$56@58.00	$65.00@70.00
New York—Yel. Pine	$54.25	$46.75	51@53.50	60.00@67.50
Buffalo—Yel. Pine	59.00	.....	.....	49.50@53.50
Chicago—Yel. Pine	50.00	39.00	.....	$58.00
St. Louis—Yel. Pine	30.00	39.00	.....	41.50
Seattle, Wash.—D. Fir	57.00	.....	.....	26.00

Southern Mill Prices

	Flooring, 1x4, No. 1 flat	2x4, 16 ft., No. 1	Timbers, No. 1, 4x4 to 8x8	Timbers, No. 1, 3x12 to 12x12
Alexandria—So. Pine	$45.00	$31.25	.....	.....
Birmingham—So. Pine	45.07	30.83	.....	.....
Hattiesburg—So. Pine	45.63	32.34	$28.31	.....
Kansas City—So. Pine	.....	30.81	35.32	$50.75

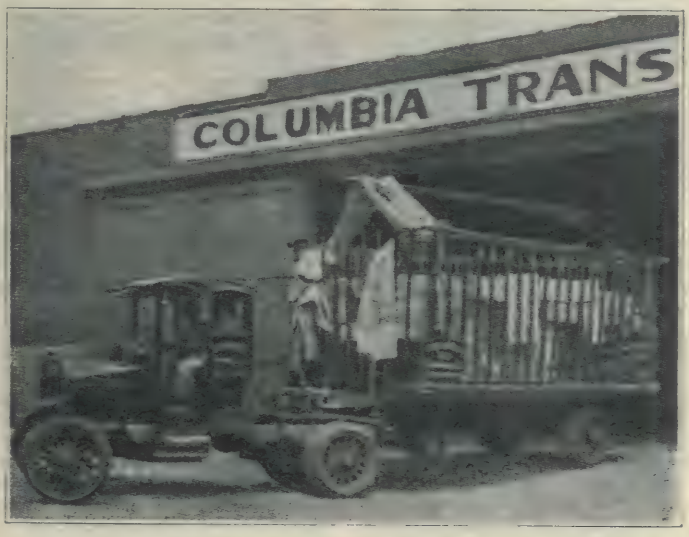
Coordination of Rail and Motor Service

How Private Company Handles L. C. L. Traffic at St. Louis Described in Railway Age

The handling of less than car load freight to and from freight houses of the roads terminating at St. Louis, Mo., and East St. Louis, Ill., and in interchange between these roads, has been developed in a way that is both unique and efficient. It consists of a cartage system, supplemented by off-track union freight stations at which freight is handled for all roads. This service is rendered by the Columbia Terminals Co., a private corporation which operates under contracts with the roads and in accordance with published tariffs.

Five off-track outbound stations are maintained by the Columbia Company in different localities in the business section of St. Louis at which freight is received from shippers, for all railroads terminating at East St. Louis and St. Louis. In no case does the company call at the shipper's door for freight. Three inbound stations are also maintained for the accommodation of freight brought to East St. Louis by the railroads for St. Louis consignees. In cases where the consignee directs the company to make delivery to his place of business, it does so, but directions of this character are received in a comparatively small percentage of cases. Unless directed to make the delivery, notice is sent by the Terminal Company to the consignees and the freight is hauled from its stations by their draymen.

Transfer Co. Assumes Full Responsibility of Common Carrier.—In the performance of this service, the Terminals Company assumes full responsibility as a common carrier. It participates in the settlement of claims while the charges for its services are fixed in published tariffs which apply uniformly to all off-track stations. Its revenue averages $2.14 to $2.25 per ton for outbound traffic and $2.34 to $2.75 per ton for inbound traffic. The average rate received on interchange freight is $1.90 per ton. For these rates, the Terminals Company provides the facilities at the off-track stations, and assumes all expense of handling the freight at these points and to or from the houses of the individual roads. It makes out all waybills, issues receiving notices, etc. It also pays all freight charges to the roads and collects from consignees and shippers.



Tractor and Loaded Trailer Leaving Station.

While this freight was handled

originally by horse-drawn wagons, for which a maximum of 300 teams were in service at one time, the Columbia Company began to experiment with motor trucks in 1914. In adapting them to this service, it was found possible to transfer a considerable proportion of the traffic directly from the shippers' trucks to those of the terminal company, thus saving labor, expense and platform space.

Development of Trailer System.—Because of the necessity of holding the motor trucks during this transfer, they did not prove economical and attention was then directed to the development of a system of trailers which could be loaded "dead" and moved by tractors. In 1909, a tractor and three Lapeer trailers were purchased and they proved so satisfactory that others have been added until today 63 tractors and 197 10-ton trailers are in service and more will be added regularly until the remaining 300 horses now employed are relieved. It is anticpated that 125 tractors and 400 trailers will enable all of the horses to be eliminated. The tractors are of Packard, Mack and Pierce Arrow construction, while the trailers are all of the type originally purchased.

This tractor-trailer system permits one tractor, which involves the heaviest investment, to handle three or four trailers as fast as they can be loaded and unloaded, thereby reducing its non-productive time to the minimum and securing the maximum return from the investment. The tractors make an average of 25 miles per day. From the standpoint of the railways, a surplus of trailers at the freight houses enables a considerable amount of freight to be trucked direct from cars to the trailers, while as the trailers stand in the streets or driveways they do not interfere in any with operations within the house.

This system of cartage is adapted to the conditions existing at the 21 freight houses in St. Louis and East St. Louis, which were built for delivery of freight by teams. The trailers require no additional expense for equipment on the part of the roads, neither do they encroach on the floor area in the houses. As the trucks deliver full loads to each house, the team congestion is reduced greatly.

Operation of System.—In the operation of this system only freight for one freight house is loaded on a trailer, although no attempt is made to concentrate it beyond that point. The average load on a trailer is six tons. As a trailer is loaded a central truck dispatcher is notified who sends a tractor for it. The driver of the tractor is given a manifest of the load, enabling over or under loading to be detected quickly. The terminal company has a representative in each freight station, while a general superintendent is in charge of operations on each side of the river.

At the present time this company is handling in excess of 6,000,000 lb. of freight per day, comprising about 15,000 individual shipments. As indicative of the distribution of this traffic, the following statistics refer to operations during March, 1923.

Tonnage outbound delivered to all roads on both sides of river	72,990,211
Total tonnage received at west side stations	20,540,208
Tonnage received at west side stations for St. Louis	7,473,694
Tonnage received at west side stations for the west side roads	6,001,502
Tonnage received at west side stations for the east side roads	7,065,012
Total tonnage received from east side roads	69,866,832
Tonnage received from east side roads for St. Louis	26,484,053
Tonnage received from east side roads for the eastern roads	6,191,827
Tonnage received from east side roads for the west side roads	37,190,952

Of the outbound traffic originating at St. Louis practically all is loaded out of the railway stations on the same day it is delivered to the Terminals Company, while about 87 per cent of that handled in interchange is delivered to the connecting line on the same day it is unloaded at the station of the incoming road. This compares with an average interval of five days for interchange movement by rail. The value of this prompt movement in taking freight from the roads is indicated by the fact that there has been no congestion at any freight house in St. Louis or East St. Louis during the recent periods of heavy traffic, a condition which stands out in marked contrast with those prevailing in most other large cities. This has been made possible by the Columbia Terminals Company driving the consignees harder than the roads are able to remove their freight as a result of which it gets quicker action than an individual road competing with others. This is indicated by the fact that this company handles an average of 2.68 tons of freight in and out per square foot of floor space per year, as compared with an average of 1.73 tons in the railroad houses. Furthermore, when a road is handling a large

amount of freight inbound, as many as 50 to 60 trailers are loaded frequently after the regular closing time in order to release cars.

As stated above, the Terminals Company participates with the roads in the settlement of all claims. To eliminate overs and shorts, drivers are held at the stations whenever discrepancies are discovered until the consignor is communicated with, thereby clearing up most errors promptly. By this and other similar measures, claims of all kinds embracing shortages, damages, concealed losses, etc., are kept down to an average of less than $1,400 per month or below 1 per cent of the revenues.

In making this plan effective attention has been given to the enlisting of the co-operation of the employees, special attention has been given to their education and the importance of handling freight carefully and a bonus is offered all employees to stimulate the output of their work.

Spotting a Gravel Barge With a Crane

A simple and ingenious method of moving a barge loaded with gravel was observed recently on the waterfront of a Hudson River town, state Successful Methods. The barge had been moored to the dock at a point where it was inconvenient to unload and it had to be pulled along about 50 or 60 ft. A crane mounted on crawler traction and equipped with a clamshell bucket was handling the work of unloading, so it made its way along the dock to where the barge was moored dropped its bucket into the gravel, letting it dig in far enough to get a firm hold, and then started back to the unloading point where the trucks were waiting. By avoiding a sudden jerk in starting which might have pulled the bucket loose, the crane operator managed to pull the barge along against the tide until he had it where he wanted it. Then he closed the bucket tight hoisted out the first load and began filling up the nearest truck.

A $30,000,000 Railway Project in Canada.—Press reports state that the Canadian Pacific Ry. is planning the construction of a direct outlet for the Peace River country in Northern Alberta at an approximate cost of $30,000,000, and that survey parties are now engaged in preliminary work.

Selecting the Qualified Contractor

Questionnaire for Determining Skill and Responsibility of Bidders

Bids were taken early this month on a flood protection job at Vicksburg, Miss. The work being of a somewhat special type, the engineers, the Miller Butterworth Co., of Little Rock, Ark., decided to use the plan adopted sometime ago by the Kentucky State Highway Department of requesting the bidders to submit answers to a questionnaire covering their skill and responsibility. The questionaire follows:

The work contemplated is of a special nature, care will be taken to secure a contractor who has the necessary skill and ability to handle such work. To this end an effort will be made to eliminate inappropriate bidders before their proposals are opened, by having each bidder make satisfactory answers to the following questionnaire before his bid will be accepted. The information given will be treated in strict confidence, will be returned immediately after it has served its purpose and no copy will be kept, in fact, the questionaire sub-Chief Engineer will be returned unopened.

The decision reached will not necessarily be one of fact as to the ability of the person submitting the answers, but simply the opinion of those called upon to select an appropriate contractor for this particular job; other or fuller information might change this opinion. A rejection in this case will reflect in no way whatever, on the proponent, in any further work.

SKILL:

1. How long have you been in business as a contractor?————

2. How long have you been in responsible charge of work?————

3. What training in school, college, or elsewhere have you had to fit you for this business?————

4. Give a concise outline of similar work you have done, with examples and dates from your start in the contracting business.————

5. Give a list of similar work to that in view, with brief description, size, location and date, that you have executed. ————

6. Have you a skilled superintendent now in your employ competent to be entrusted with executing the work

in your view?——————

7. State the training and experience of the man you propose to put in charge of this work.——————

8. Have you now in your employ the principal assistants to the works' superintendent for the work in view?

9. State their position, training and experience. ——————

10. Do you propose to sublet any parts thereof, if contract is awarded to you, or execute it all yourself?

11. What part or parts do you propose to sublet if contract is not executed by you?——————

INTEGRITY

12. Give the names and address of the last five engineers and the owners of the work, with address, for whom you have completed contracts.——

13. Will you give them as references. ——————

14. Have you any objection to my inquiring of any or all of them about you? ——————

15. If so, why? ——————

16. Give any other reference you care to. ——————

17. Has any work been taken out of your control because of dissatisfaction of engineer or owner?——————

18. If so, describe the case.——

19. Have you had controversies with your subcontractor or with improvement districts? ——————

20. If so, state the nature of them.

21. Have any of your contracts resulted in lawsuits? ——————

22. If so, describe the cases. ——

RESPONSIBILITY

23. I estimate that if you fulfill the requirements of plans, specifications and contract as to progress, the amount of cash and credit exclusive of equipment required of contractor before the first substantial payment is made will be $20,000.00, and that the maximum requirements of cash or credit in the most active period of the work between payments will be $30,000.00.

24. Have you the required resources in cash or credit?——————

25. Give a condensed statement of assets and liabilities. ——————

26. Will the above condensed financial statement favorably compare with the detailed statement you will render a surety company when applying for a bond? ——————

27. What volume of work have you unfinished? $——————

28. How much cash or credit does this require? $——————

29. How much cash or credit does this leave free for other work? $——

30. I estimate approximately that the following plant will be the minimum amount needed to properly handle this work. Locomotive Crane, Clam Shell Bucket, Steam pile driver, Concrete Mixer, 200 Lineal Feet of Forms, Unloading Crane with Bucket, Bins for Materials, Means for Transporting Materials.

31. Have you this amount of your own available for the work?——————

32. If not, do you know that you can get it as and when needed?——————

Rail Maintenance and Conservation

A Paper Presented June 13 at Annual Meeting of American Association of Railroad Superintendents

By F. W. CURTIS,

Superintendent, Minneapolis, St. Paul & Sault Ste. Marie Ry.

The proper maintenance and conserving of rail is of considerable importance to a railroad in maintaining the track at the necessary standard to insure safety and economy in operation of its trains and the upkeep of the track. If it is good economy to buy the best quality of rail, which I think all will agree is so, it is certainly poor economy to neglect the rail after laid in track and allow it to be damaged by unfair usage and lack of proper care. When such is the case the life of the steel is shortened, with the result that it has to be removed from track before it should be changed out, thus causing loss and unnecessary expense.

Proper Care of Rail Important.—Many section foremen and roadmasters fail to realize that rail is a very heavy item in the cost of building and maintaining track and that the proper care of it is a very important matter and that lack of care and misuse will result in unnecessary expense in maintenance of track for their company which could have been prevented by the exercise of care on their part. Frequent and careful inspection of the rail on their sections by the foremen for defects which may be of serious nature and result in a derailment is very necessary. In many cases foremen will go over their track day after day and not notice signs of defect and deterioration in a rail that should

have been apparent to anyone familiar with the proper aspect of rail.

Roadmasters are often remiss in this respect and do not develop the presence of defective rails in track which are liable to give out under traffic and cause a serious accident, with loss and damage to the company by reason of damage to freight and equipment and possible injury or death to passengers and employes.

Roadmasters Should Regularly Inspect Main Line Rail.—There should be intelligent inspection given to rail in main line track at regular intervals by roadmasters, the frequency of such periodic inspection depending on the density of traffic, weight of rolling stock, and nature of the roadbed in order to prevent the continuing of defective rails in the track or prevent conditions which result in deterioration of rail. Such inspection as is necessary in order to insure this cannot be made from the rear end of a rapidly moving train but must be made by either walking over the track, or by riding on hand car or motor car at such rate of speed that the condition of rail can be noted properly.

Too often roadmasters think they must try and get over as much of their track in a day as they possibly can when making an inspection trip on motor car, which is undesirable from the standpoint of safety and also thorough inspection not being afforded. It is not possible to cover 100 miles in a day on motor car on a rail inspection trip and give rail the proper degree of attention to develop defects. I have known roadmasters to do so and claim they gave the steel close and careful attention. Such inspection as they could give under such conditions would be only superficial and of little value.

Conditions That Cause Deterioration.—I will briefly call attention to some of the defects which develop in rail and conditions that cause deterioration. The flattening or battering of the rails at ends due to joints not being kept up to proper surface, and neglect in keeping the bolts tight is a common source of damage, it is very apt to be prevalent on inside of curves and in the majority of cases is chargeable to negligence and lack of proper attention.

When joints become battered they cannot be overcome by raising and the only way that the damage can be satisfactorily repaired is to either saw off the battered end and re-drill the rail or build up the battered surface by welding. The latter remedy is preferable to the first, as it is not as expensive as resawing, and has been proven to be a success and an absolutely safe method of reclaiming of rail by the railroads that have adopted the welding process.

The flange wear on head of rail is a condition that should not be neglected, especially on the head of the outside rail on curves of three degress or over and when rails have become worn so that the limit of safety has been reached, they should be replaced without delay.

The flange wear on head of rail should not be allowed to exceed ¾-in. as wear in excess of this constitutes an unsafe condition which should not prevail, particularly where speed of trains is high. It is economy to transpose rails on curves from the inside to the outside and vice versa after the limit of flange wear is apparent. This should be done before the inside rail becomes battered to any extent. Transposing of the rail, if properly done, will give an additional life of five or six years on curves of 3 deg. or over and longer life on curves of less degree of curvature.

Gauge of Curves Important Feature.—The gauge of curves is an important feature of maintenance of track and it is very essential that proper gauge be maintained on all curves. Improper or wide gauge on curves results in damaging the inside rail as with wheels that are worn so there is a ridge or flange on the outside of the wheel, particularly with worn driving wheels on engines that will ride on the head of the rail if the gauge is wide, which will result in damage to the rail.

The presence of piped rails in track is a serious condition and extremely unsafe and liable to result in derailment in case the ball of rail should break out. The piping rail is indicated by a dark streak lengthwise on top of the head of rail and whenever this exists it will be found that there is a red streak underneath the head of the rail resembling a red pencil mark. This is caused by the moisture from the top of rail soaking through the seam or defect and forming a corrosion under the head of the rail. A piped rail can often be detected also by a dropping down or depression in the head of the rail over the piping.

The Danger from Internal Fissures.—Another defect in rail which is very

serious and a great menace to safety is the internal fissure. This defect is such that it is practically impossible to detect it as the rail does not show any external sign of defect and there is nothing that can be done to discover its existence and the first intimation of such defect is when the rail breaks under traffic. When a rail breaks and it is apparent the breakage is due to internal fissure, steps should be taken to obtain the heat number of the rail and the only safe thing to do is to remove all rails of such heat number from the track and not take chances of having other rails break due to such defect.

The internal fissure rail is extremely dangerous to have in track and liable to result disastrously if allowed to remain in the track.

When rails develop broken bases it is economy to drill them and reinforce with angle bars and so continue them in the track instead of taking them out. This can be done with perfect safety where there is one crescent break not more than 20 in. long, rails with two or more such breaks in the base should be taken out of main track and used for side tracks.

Where rails break 5 ft. or less from end of the rail they should be taken out of track. Rails that break at a distance of more than 5 ft. from the end of the rail should be examined closely. If the break is found to be a square break and shows no sign of any visible defects, the rail should be drilled and a pair of angle bars applied and full bolted and kept in track. In case of a rail breaking in more than one place it should be removed from track at once.

Combined Electric Welder and Grinder

By mounting welding and grinding outfits on a 2-ton Ford chassis, Walter Uffert, Master Mechanic, New York & Harlem R. R., New York, has produced a portable unit that can be handled by two men. The arrangement is described in the Electric Railway Journal, from which this note is taken.

Both welding and grinding operations can be carried on simultaneously. Welding leads of 100 ft. in length are provided, so that the welder can work on joints for this distance ahead of the truck. The grinding operation is performed at the rear of the truck so that this can follow the welding without interference.

Welding and Grinding Operations Under Way at Same Time.

The welding and grinding equipment is mounted on a substantial angle-iron framework in the rear of the driver's cab. Six frames of grid resistance are mounted in two tiers immediately behind the cab. Circuit breakers are placed in the welding circuit ahead of the equipment and the current graduations are obtained by knife switches.

The New York & Harlem R. R. uses the underground conduit contact system, and current for welding is obtained directly from the contact rails by use of a plow. Four receptacles are provided on the left-hand side of the truck. Two of these are for the plow leads and the other two for the welding leads. Plugs with substantial wooden handles are used for plugging in to obtain the necessary connections. Copper rods with substantial porcelain insulators are used for all connections to the resistor grids and to the switches and circuit breakers. There

is thus no danger of charring insulation from too much heat and at the same time this method of construction is neat and compact.

In mounting the grinding wheel, special attention was given to flexibility so that the grinding wheel can be removed from one rail to the other and can be pushed backward and forward without the necessity of shifting the truck. A 3 h.p. 600-v. G. E. belted to a countershaft mounted just motor is used for driving. This is behind the grid resistors.

New Features of I. C. R. R. Water Softening Plants

The Illinois Central R. R. has recently completed nine new water treating plants and has converted three old intermittent plants into plants of the continuous type and increased their capacity about 75 per cent. In addition this road now has eight new plants under construction. When these plants are completed all water used from Clinton, Ill., through Freeport, to Omaha, Neb., a distance of 600 miles, will be treated, and a total of 40 water softening plants will be in service on the system. The new plants are all of the continuous type and represent a new design of water treating plant in the construction of the tanks and housing. We are indebted to an article by C. R. Knowles, Superintendent Water Service, Illinois Central R. R. in Railway Engineering and Maintenance, for the following information regarding the plants.

The tanks are of conical bottom type with riser pipe and are built in three sizes for plants having hourly capacities of 10,000, 20,000 and 30,000 gal., respectively. They are built in two heights, 35 ft. and 50 ft., the 35-ft. tanks being employed for rehandling plants and the 50-ft. tanks for gravity plants. Five hours' reaction time is provided in all cases, the capacity of the tanks being 50,000, 100,000 and 150,000 gal. Each tank is built with a conical bottom and standard 6 ft. riser pipe, the height of the riser pipe varying from 12 ft. on the 50,000 gal. tank to 8 ft. on the 150,000 gal. tank.

The treating plant houses are of a uniform design and are built in two sizes, 20 ft. by 40 ft. and 20 ft. by 60 ft., depending upon the capacity of the plant and the amount of storage space required. A space of 20 ft. by 20 ft. is reserved for the chemical equipment, filters, etc., and the remainder is used for storage of chemicals, the smaller house having storage space for two cars of chemicals and the larger house for four cars. That portion of the house reserved for the equipment has a 12-ft. ceiling to allow the necessary headroom for tanks, shafting, etc., which the storage room has a 10-ft. ceiling, as it is impractical to pile the chemicals in storage higher than 8 ft.

Conical Bottom Tank a New Development for Water Treatment.—The outstanding feature of these new plants is the conical bottom tank which is a radical departure from the commonly accepted practice of building flat bottom steel tanks of the standpipe type resting upon a concrete ring filled with broken stone or elevated wood tanks of similar design. A great deal of attention was given to the tank in designing these softening plants, and the conclusions reached, which have been borne out in practice, may be of interest.

While the conical bottom steel tank has been used extensively for the past 15 or 20 years as a roadside storage tank and in one or two isolated cases as a combined storage and settling tank, the Illinois Central treating plants are believed to be the first examples of its application purely as a water treating tank. It is true that water treating plants have been built with a cone within the settling tank, and some designs still embody the cone, either in an upright or in an inverted position, but it seems that the conical bottom principle is applied to the outer shell or bottom of the tank with a riser or mud drum has not been given serious consideration by designers of water treating plants.

It is generally conceded that this type of tank presents a more pleasing appearance than the flat bottom standpipe type of tank commonly used as a treating tank, and it is claimed to be more efficient and economical in many other respects. While some of the points claimed for it may be open to question, the Illinois Central tanks are proving a very satisfactory and practical design of tank for water softening.

Principal Advantage of Conical Bottom Tank.—The principal advantage of the conical bottom tank in water softening is found to be in the collec-

tion and removal of the sludge and the resultant saving in water used for sludging over the flat bottom tank. This feature alone will pay a good return on the cost of the tank. In the flat bottom tank the sludge is distributed over the entire bottom of the tank and its removal necessitates the construction of an expensive sludge collecting system, usually consisting of pipe with openings placed at intervals over the bottom of the tank, the most efficient of which are so arranged that the system may be operated in sections with from two to four sludge valves for each tank. Another type of sludge system is so constructed that the collecting pipes may be rotated over the bottom of the tank. None of these systems have been found entirely satisfactory, however, as they will not completely remove the sludge and are wasteful of water, as the sludge nearest the outlet is the first to be picked up and from two-thirds to three-fourths of the openings are discharging clear water long before the sludge near the outer edge of the tank is disturbed.

The sludge falls to the bottom of the conical bottom tank and accumulates in the mud drum or riser where it is easily removed through a single opening and with a minimum waste of water. Actual tests to determine the amount of water in removing sludge show that the flat bottom tank requires from four to eight times more water than a conical bottom tank, depending on the efficiency of the sludge system and the amount of sludge deposited.

Tests of Flat Bottom and Conical Bottom Tanks.—A test was made to determine the amount of water required to remove the sludge from a flat bottom tank 22 ft. in diameter after 12 hours operation, during which time 120,000 gal. of water had been treated, the sludge amounting to approximately 520 lbs. About 5,000 gal. of water was wasted and while a great deal of the sludge was removed, the tank was not clean by any means and repeated opening and closing of the sludge valve brought quantities of sludge, the stream of water being clear with streaks of sludge through it. The tank was drained of all water and it was found that the openings in the sludge system collected the sludge for a short distance around the openings and the sludge had accumulated to a depth of 3 ft. all around the edge of the tank. There was also a great deal of sludge between the sludge lines. Examination of the tank proved conclusively that the removal of sludge in a flat bottom treating tank is very expensive in the use of water and in most cases is inefficient and incomplete so far as the complete removal of the sludge is concerned.

A similar test was made with a conical bottom treating tank 28 ft. in diameter. After 60 hours' operation, during which time 1,000,000 gal. of water had been treated, and the sludge deposits amounted to over 4,000 lb., it was found that 2,300 gal. of water was sufficient to remove the sludge completely. The practice on the Illinois Central is to wash the sludge out twice a day and the water required for this purpose rarely exceeds 1,200 or 1,500 gal. daily, while to do the same work in a flat bottom tank would require 8,000 or 10,000 gal., a conservative estimate of the amount of water saved daily being 7,500 gal., which, at the low rate of 15 cents per thousand gallons for pumping and treating, means an annual saving of over $400 per year or six per cent on an investment of over $6,500.

The conical bottom tank also has a decided advtantage over the flat bottom tank for water softening in the rate of upflow. For example: a 30,000 gal. per hour treating plant will require a tank of 150,000 gal. capacity (based upon Illinois Central practice which provides five hours' reaction and settling time). Assuming a height of 50 ft. for the softening tank a flat bottom tank of the desired capacity will have a diameter of 22 ft. 6 in. and a rate of upflow of 8 ft. 4 in. per hour. A conical bottom tank will have a diameter of 28 ft. 8 in. or a rate of upflow of 5 ft. 4 in. per hour. If the reaction time is only four hours, which is common practice, the rate of upflow in a flat bottom tank is over 12 ft. per hour while the rate in a conical bottom is less than 8 ft.

Other advantages found in the conical bottom tank are greater convenience for location of piping, valves, etc. The inaccessible portion of the bottom is reduced to a minimum which permits better maintenance as there is only a small portion of the bottom that cannot be painted. This design also permits better foundation design and distribution of load.

The Design of Railway Terminal Stations

Principles to Be Considered In Evolving Proper Plan Outlined In Paper Presented July 12 at 53rd Annual Convention of American Society of Civil Engineers

By ALFRED FELLHEIMER,
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A passenger terminal improvement represents perhaps the largest single expenditure the railroad makes for an individual improvement, and the degree of skill with which it is planned to a great extent predetermines its future as an asset or a liability.

In addition to the obvious railroad necessities, the designer is usually confronted with numerous important conditions, such as the economic soundness of the project and civic or other requirements for the present and future. As each problem presents controlling features peculiar to itself, a plan carried out elsewhere cannot be successfully copied. The designer must, therefore, rely upon his ingenuity, skill and vision in devising a plan which will completely achieve the desired objective and satisfy all requirements with due regard to their relative importance so that when the details have been correctly applied, a vitalized, successful plan will result.

THE CREATION OF THE BASIC PLAN

Preliminary Considerations

The terminal in its broadest sense should provide an efficient instrument of service for the handling of railroad traffic,—permit the full utilization of the by-products for revenue,—satisfy the requirements of city development,—and render public service in the largest measure.

Certain tendencies, such as (1) Electrification, (2) Relation of Rapid Transit Systems to the Long and Short Haul Passenger Traffic, (3) Merging of Terminals, and (4) Identity of Interest between Railroad and Community,—are controlling elements affecting Terminal Station Design.

Electrification.—Electrification within the strictly terminal zone of some of our large cities, has received a distinct impetus in recent years. Its advantages from a purely railroad operating standpoint would not ordinarily be sufficient to justify the scrapping of existing plant and equipment. On the other hand, when the terminal is located in a part of the city which is already desirable or may be potentially so for commercial building development, electrification permits of an intensive use of the property which is not possible with steam operation. The use which may be made of overhead or air rights to produce revenue without serious effect on the operating facilities which may be placed at or below the street level may, in conjunction with such other advantages as electrification may bring to the specific problem under consideration, be sufficient to justify its fixed charges. One of the most striking illustrations of the intensive use of all property in and about a passenger terminal, is the development at the Grand Central Terminal in New York City.

Relation of Rapid Transit Systems to the Long and Short Haul Passenger Traffic.—As most railroad terminals are inspired primarily by the necessity of providing for long-haul passenger traffic, the handling of short-haul (suburban) traffic should not be allowed to become a limiting factor in the life of the Terminal. Suburban traffic generally develops faster than through traffic and often threatens to absorb an undue proportion of the terminal facilities. This situation is aggravated by the modern tendency of long-haul through travel to attain its peak load coincidently with the short-haul peak.

Serving nearby suburban or urban traffic is logically the function of rapid transit systems, which have in general failed to keep pace with the unprecedented growth of many of our large cities. In consequence, an undue share of this traffic is forced into the railroad terminals.

To the extent that the volume of this nearby suburban or urban traffic is reduced its terminal service facilities may be restricted,—unremunerative business eliminated, and capital expenditure lessened, making available more space and capital, if needed, for greater development of the long-haul traffic terminal service.

In view of these circumstances, it is clearly an advantage to divert as much as possible of the urban and nearby suburban traffic from the terminal, consequently, definite consideration should always be given to the feasibility of arranging or providing for co-operative trackage rights and physical connections between Railroad and Rapid Transit Systems, existing or proposed, outside the terminal limits, thus assuring relief of the terminal from the burden of this concentrated service, and affording the public in the greatest degree door to door transportation.

Merging of Terminals.—As serious public thought is now being given to large consolidations of railroad properties, consideration should be given to the anticipation of them and the changes involved in their accomplishment, including merging of terminals.

This involves broad questions of policy and economics of operation. The value of the land which may be released is often one of the major points advanced in favor of such a project. Before deciding in its favor, however, due weight should be given to the possibility, under electrification, of the railroad use and commercial development jointly, through the utilization of the air-rights thereby made available.

It has been demonstrated that, given the opportunity, business activities will center about an electrified railroad passenger terminal, to take advantage of the accessibility of transportation and the potential business possibilities created by the movement of large numbers of passengers through the various approach thoroughfares. In addition the desirability of the air-right space is increased by the continuous control of a single ownership.

Through the mutual reaction of these favorable elements, it is not unlikely that the values thereby created will be greater than those following the full release of the same property for non-railroad use.

Identity of Interest Between Railroad and Community.—In principle, the interests of the railroad and the community it serves are in the last analysis the same, and the Terminal plan should express such identity of interest.

Municipal and other public officials should therefore approach the solution of these problems as far as the elements they themselves represent are concerned, in the spirit of wholehearted cooperation. And so too, the railroads, not only as concerns the public interest but also as between themselves where the terminal project affects directly or indirectly more than one railroad.

General Requirements.—The preliminary examination must determine that the project satisfies the following conditions:

That the improvement at the proposed site as compared with other available locations, is desirable from the viewpoints of construction and operating costs, including car unit costs. This is particularly important for locations so restricted in area that double-deck structures may be necessary to secure required capacity.

That suitable development can be made in stages to meet the expected normal growth in the services involved for a sufficient term of years to justify the project.

That the proposed improvement is desirable from the viewpoint of the municipality and in harmony with its plans for development.

That the advantages offered to the public are sufficient to justify such concessions as may be required from the municipality.

That the project in its entirety, presents a sufficiently favorable economic aspect, free from insurmountable prior obligations, to insure its complete financing along rational lines.

That the by-products of the development such as the overhead or air-rights can be utilized in a practical and profitable way so as to absorb, or at least substantially reduce, the carrying charges of the improvement.

That the project as planned is so sound and free from imposing burdensome conditions upon the railroad, that controlling or governing bodies will readily approve same.

That the improvement is of such type that adequate enhancement of land values within the terminal area will necessarily follow.

Specific Requirements.—The foregoing broad principles being satisfied, the basic idea must be in harmony with the following:

Transition from Existing Conditions to Proposed Plan.—Except at new locations, the plan must, in its general conformation, fit in with existing conditions to a sufficient extent to permit of gradual transition into the complete or final plan without serious disturbance of operation, and in such

stages as will conform with the development of railroad traffic and contiguous property. Obvious economic and practical reasons make this imperative.

Balance Between Benefits to Public and Cost.—It must strike a proper balance between the public comfort and convenience on the one side, and economy in both first cost and subsequent operation on the other. This insures good will on the part of the public, and efficient and liberal service on the part of the railroad.

Simplicity of Plan Insuring Directness.—The general layout must be orderly and direct in the placement of its principal parts, because in a project of large dimensions and scope, freedom from disorder and confusion is in direct proportion to the simplicity of the plan.

Street Arrangement and Railroad Facilities Coordinated.—The railroad facilities provided must coordinate with the complete development of streets and blocks throughout the terminal, conforming with the civic plans for unrestricted expansion of the city adjacent to or across the terminal area. This will benefit both the railroad and the public.

Flexibility in Adjustment to Future Requirements.—Facility of adjustment to future requirements must be arranged for, because the useful life of railroad facilities is limited by obsolescence rather than by physical decay. Such facilities, therefore, can be considered stable or permanent only insofar as they are adjustable to changing conditions. This applies with special force to terminals which must, in their initial stages, be operated by steam.

Adequate Trackage in Approaches, Throats and Yards.—Definite determination must be made of the adequacy of approaches, throats and yards, to assure ample capacities of trackage, all in proper balance, thereby making possible a high degree of operating effectiveness.

Selection of Characteristic Basic Types

After the plan has been proven to be in accord with the preceding requirements, determination must be made of certain characteristic basic types, as follows: (A) Through or Stub type of track facilities, as affecting train operation, and (B) Head-House type of station facilities, as affecting station operation.

The designation "Terminal" while strictly applying to a rail or operating "Terminus" only, is, in this paper, used as referring to a station of either the stub or through type of track facilities.

Through Type.—This layout, where the track facilities provide in part or whole for through train operation, is concededly best adapted for efficient and rapid train handling, and is therefore, where choice can be made, the type to be selected unless a careful investigation of all the elements affecting the correlated and dependent facilities, fails to disclose the necessary preponderance of factors in its favor.

Stub Type.—This type, where the train operation terminates at the station, can, where the conditions permit, be given some of the special advantages of the through type by providing a loop or engine release arrangement.

In the stub type of terminal, except in cases where there is a difference between street and track level, the platforms and other facilities can be arranged at one level. This results in advantages as follows:

Highest total efficency in operation and the greatest convenience to the public.

Freer and faster travel on platforms, unencumbered by stairs or ramps.

Practical elimination of vertical travel of passengers between streets and platforms.

Economy in construction cost, maintenance and operation.

The short haul (suburban) traffic with its intensive service requirements should, wherever possible, be provided with means for through or continuous train operation.

A definite selection must be made of one of the three general types of Head-house before proceeding with the consideration of the arrangements of the detail features:

Waiting Room Type of Head-House.—Where the Waiting Room is made the focal center of the Station, with all dependent facilities such as ticket office, baggage and check rooms opening directly therefrom and with separate passenger concourse for access to train platforms. The Washington Union Station is an example. (This arrangement tends to make the main waiting room a thoroughfare between the street and the trains.)

Concourse Type of Head-House.—Where a large general passenger concourse is provided for the mass move-

ment of passengers, with ticket office and other dependent facilities opening directly therefrom, the Waiting Room with its auxiliary facilities being placed adjacent to but separate from the Concourse. The Grand Circuit Terminal, New York City, is an example. (This type tends to minimize conflict of foot passenger traffic.)

Composite Type of Head-House.—Where a large room is provided exclusively for the sale of tickets, checking baggage and like dependencies, with separate waiting rooms and passenger concourse. The Pennsylvania Station, New York City, is an example. (This type tends to create cross-currents of travel between the various station facilities.)

ELABORATION OF THE DESIGN

Traffic Considerations

Extreme Peak Conditions of Traffic Not to Govern.—While station facilities should be planned to accommodate anticipated traffic, including normal frequently recurring peaks, it is not essential to provide for occasional extreme peak conditions, since, in a well planned station, an overload can be carried by all facilities for short periods without undue operating stress or inconvenience to the public.

Foot Traffic Channels—Natural and Direct.—The general arrangement should invite movement of foot traffic along natural and direct channels so that passengers may, as far as practicable, avoid crossing the main travel routes and the retracing of steps.

Where established lines of city foot traffic are permanently interrupted by the terminal construction, provision should be made to accommodate this traffic without interfering with the normal use of the Station.

Separation of Suburban and Through Foot Traffic.—The separation of suburban and through traffic should be effectively accomplished in order to avoid confusion and expedite the movement of both classes of traffic. It is not essential that entirely separate Concourse, Waiting Room and general facilities be provided. It is necessary, however, that the main channels of circulation be completely separated.

Separation of Inbound and Outbound Traffic.—While it is desirable to separate the passenger foot traffic channels and allocate sections of the terminal facilities to inbound and outbound traffic, no physical division should be planned in the track layout that will limit interchangeability and elasticity.

The baggage facilities for receiving, delivery and storage should be separated. Trucking subways, bridges and other passageways may be used in common.

Adequate provision should be made for the public and private vehicular traffic in suitable relationship to station facilities.

In addition to access to streets, convenient entrances and exits should be provided for interchange of passengers with surface car lines or other local transportation systems.

The plan should provide for direct contact with all natural points of entrance and exit rather than force the diversion of traffic to points dictated purely by the necessities of the Architectural Composition.

Provision should be made for direct traffic contact by means of trucking and elevator facilities, with the passenger platforms.

Where this traffic is in solid trains, consideration should be given to its location outside the terminal.

Segregation of Freight Traffic.—Where the terminal plan includes provision for freight traffic, this portion of the layout should be entirely segregated from the passenger facilities and, as far as possible, all freight driveways should be separate from the main streets or thoroughfares, in order to minimize the interference in the operation of these facilities with passenger and public traffic.

Station Facilities

General Requirements.—The various facilities comprising the Station proper must be placed in the natural and orderly grouping which their logical related uses dictate. The individual sizes of adjacent facilities should permit modification, if future requirements so dictate, without seriously disarranging the general coordination of the plan.

The Passenger Concourse.—This should be roomy and entirely enclosed with weather-tight gates at the train platforms. These train gates should preferably be in a continuous line on one side of the Concourse. The Concourse should be free from confusing changes in direction; ample and direct access should be provided from the Concourse to strategic street points and the various Station facilities.

The Waiting Room.—These should be arranged to be conveniently accessible for patrons from the street and

station facilities without inviting usage as a thoroughfare, with all facilities for the comfort and accommodation of waiting passengers located adjacent and readily accessible. The location should permit of adequate ventilation and daylighting.

The Ticket Office and Checking Facilities.—These should be placed in contact with, but not encroaching upon the main routes of travel between streets and trains, so that persons not requiring these facilities may pass without conflict with passengers buying tickets or checking baggage.

All working facilities should be provided with conveniences and equipment required to insure the full working efficiency and comfort of the employes.

Concessions. — Revenue producing facilities conducive to the comfort and convenience of the passengers should be located along the main arteries of travel, placed so as not to reduce the effectiveness of Station operation. Their arrangement should insure maximum patronage from the general public and railroad patrons, thereby enhancing their rental value.

Architectural Objective of the Design.—The elaboration of the Architectural features of the design should reasonably express the purpose of the improvement and emphasize the relative importance of entrances, exits and like features. Attention should be paid to mass effect which attracts the notice of the general public rather than to details which are seen or appreciated only by a few. Economical consideration should be a definite aim throughout including the avoidance of especially elaborate constructional detail.

The station plan should impose on the office building no limitations which will exclude any essentials needed to assure successful competition with similar commercial buildings.

Where the character of overhead buildings can be predetermined, as requiring contact with the station, freight or other facilities, it should be provided for; otherwise, flexibility should be given, making possible future conversion to suit the requirements.

Platforms and Ramps

Platforms.—These should be level with the car floor, especially for suburban service. If conditions compel the use of low platforms, provision should be made for future conversion to the high type.

Where the width of platform is restricted by the need for intensive development of the property, the minimum should permit passengers to pass freely between loaded baggage trucks when placed along either side of the platform.

Means should be provided to avoid trucking across platforms and tracks.

Baggage elevators should not be located in narrow platforms except at the outer end. When placed at the Concourse end they should not obstruct circulation. The enlargement of platforms at the Concourse end known as the "Midway" provides space for the location of elevators, stairs and similar facilities without encroachment upon the Concourse or interference with public circulation, and permits the use of several train gates at one time in speeding the exit of arriving passengers.

Separate baggage platforms are not ordinarily necessary. The handling of baggage on passenger platforms causes slight interference with passenger traffic. Suburban trains carry practically no baggage. Inbound long-distance trains normally occupy the platforms for a considerable period beyond the short interval required to discharge the passengers. Passengers for outbound long-distance trains are so thinly distributed that no appreciable interference results. However, if such platforms are provided at all, they should be of ample width, as narrow ones will be useless.

The spacing of platforms and tracks, particularly if lines of columns are necessary, should be designed to permit ready rearrangement of platform widths to meet future needs.

Column lines for superimposed structures in the absence of controlling conditions to the contrary, should be located in the platforms instead of between tracks thereby reducing danger to overhead structures, increasing the view for operation, adding to safety and facilitating maintenance. Columns in platforms interefere but slightly with passenger movement, with small loss of space, whereas, when between tracks, the space is entirely lost.

Ramps.—Where the tracks and streets are necessarily at different levels, the vertical travel, if possible, should be by means of ramps, rather than by stairways.

In general, ramps permit more

rapid circulation, cause less fatigue and minimize accidents.

Where the foot of ramp extends several car lengths or more from the Station end of a narrow platform, provision should be made to avoid backward travel of arriving passengers.

Track Facilities.—A reasonable proportion only of the station tracks need be of sufficient length to accommodate the longest trains that present power can handle, plus an allowance for increase.

Excessive rates of curvature and grades should be avoided as interfering with effective and safe operation; and tracks along platforms, especially of the high type, should as far as possible, be straight.

Where overhead building construction is contemplated, the track spacing and location of special work should afford reasonably free opportunity for placing of columns and avoidance of long building spans.

Where conversion from steam to electric power in the future is a possibility, provision should be made to permit the installation of electrical features affecting the track and platforms.

Special Structural Requirements.—In addition to the usual provisions for changes due to temperature, all buildings whose rental value or use is adversely affected by excessive vibration should, as to their foundations and other structural parts, be entirely separated from similar parts in other buildings or structures through which directly or indirectly the vibration due to rolling or live load may be transmitted.

Columns at track level where necessary should be protected by suitable collision piers to prevent failure through derailment, and should never be located in the direct line of the track immediately beyond a bumping post.

The choice of type of future electrification, if initial operation is by steam, should not be hampered by any structural limitations, such as insufficient headroom.

Auxiliary Facilities.—Provision should be made for the location of all auxiliary operating facilities such as signaling, central plants, sub-stations and equipment, entirely separate from the station facilities wherever possible but accessible to same. In determining the proper location, due weight should be given to the influence of all economic elements such as land values, economy in handling supplies and waste material, and load distribution.

CHECKING OR PROOF OF THE ADEQUACY OF THE DESIGN

General Considerations.—Averages and statistics derived from other terminals, while interesting and helpful, have no final determining value. The facts of record at the Terminal under consideration must finally govern. Each facility must be tested by the actual local requirements.

Load Co-ordination. — Consequently when the general design has been accomplished, it is imperative that the final test as to load co-ordination be applied to determine:

That all parts are in balance,
That no individual feature is under or over developed, and
That all features will simultaneously reach the saturation point.

Analysis of Operating Capacities.—To accomplish this, an analysis should be made of the operating capacity of the approach tracks, throat tracks, and body tracks, as a proper balance of these facilities is of vital importance. Likewise the relative values of practically all supporting facilities in the plan should be measured and balanced to safe-guard the successful future of the development.

As an example, the ticket office size and number of selling windows, can be definitely arrived at as they have a fixed relation to the number of outbound passengers of all classes handled which is, in turn, determined by the ultimate saturation point of the track facilities used in handling outbound cars.

It should be here specially noted that failure to check or prove the Adequacy of the Design along these lines, accounts for many of the faults and weaknesses in our terminals.

Increased Use of Permissible Explosives.—In 1912 the quantity of permissible explosives consumed in the United States represented about 5 per cent of the total quantity of all kinds of explosives produced in this country, while in 1922 it was 10.1 per cent, according to W. W. Adams, mine accident statistician of the Bureau of Mines, Department of the Interior. The total amount of explosives used for the production of coal in 1922 was 220,457,647 lb., of which 18.2 per cent was of the permissible class.

Traction Wheel Mountings for Railroad Type Steam Shovels

The Osgood Co., Marion, O. has recently built, and successful tests have been made of traction wheel mountings for one of the heaviest railroad type steam shovels. The shovel, an Osgood 120, 6 cu. yd. has heretofore been mounted only upon standard railroad trucks. On account of the time necessary in laying track for moving the shovel, railroad truck mountings were slow in getting from one point to another. This size shovel is much used in big rock quarries and open mines and usually when blasting operations were in progress it was necessary to lay track and move the shovel back from the face of the excavation and then up again after the explosives had been set off. These operations were not only costly in time and labor consumed in making the changes, but also in decreased output through time lost.

Giant traction wheels were designed that measure 6 ft. in diameter and have a face of 36 in. on the front or drive wheels and 30 ins. on the rear wheels. The front wheels are used as drivers and power is delivered through a series of gears from the powerful hoisting engines on the shovel. Steering is accomplished by turning the rear wheels by means of a screw shaft and traveling nut. The nut, to which is attached the axle tongue, moves along the screw shaft, slewing the rear axle and wheels in the direction desired. The screw shaft is operated by a separate reversible steering engine mounted above deck alongside the boiler, out of the way yet readily accessible. Reversing the engine causes traveling nut to move in opposite direction. The engine is controlled and steering accomplished by means of a single lever from the engineers position in the forward end of the cab.

In recent tests made in a large Pennsylvania stone quarry the shovel was moved a distance in one day that under old track laying methods would have required at least ten days.

The advantage claimed for traction wheels over railroad trucks for large railroad type steam shovels briefly summarized are: greater mobility of machine, elimination of pit crew, easier accessibility to face of excavation, elimination of tracks and reduction of side strains and racking to the machine in general. Traction wheels also have a decided advantage over any other type of mounting in that the traction wheels are much less complicated, simpler to operate and have a much lower upkeep cost.

6 Cu. Yd. Shovel on Traction Wheels in Operation in Pennsylvania Quarry.

Some idea of the size of the shovel can be gathered from a few figures. The shovel has an over all length of slightly more than 85 ft. and the over all width is 20 ft. with a maximum height over the cab of 15 ft. while the boom extends to a height of 32 ft.

A large stone company near Chicago has just installed an Osgood 73 3½ cu. yd. traction shovel for use in the quarry. The pit is about 80 ft. deep and is reached by a very steep incline. To get the new machine into the pit would ordinarily be quite a problem, but when equipped with traction wheels the problem was much

simplified. With boom up and dipper and handle in place the shovel was backed down the steep declivity under its own power without difficulty.

Shortly after this shovel had been placed in operation a cut of loaded dump cars was derailed when some distance from the shovel and on the way to the incline hoist. The Osgood traction shovel was thrown into gear, run down to the cars, a chain hooked over the dipper teeth and around the cars. In a few minutes the train was rerailed and on its way to the hoist while the shovel went back to the rock face ready for work. It would have been necessary to unload the cars to rerail them by hand, and then reload them. While this was being done the shovel and other cars would have been standing idle if the ready mobility of the shovel had not saved the day. The shovel has also been used about the quarry for handling boilers and other heavy machinery that would require the services of a locomotive crane.

The Osgood Co. is prepared to furnish traction mountings for its 120 6 cu. yd., 105 5 cu. yd., 73 3½ cu. yd., and 69 ft. 2½ and 3 cu. yd. railroad type shovels. Traction mountings on the 43 1½ cu. yd. have been standard equipment for some time and their successful use led to experiments which have developed the traction wheels for all sizes of railroad type steam shovels.

A 3½ Cu. Yd. Machine on Incline Preparatory to Backing Into Pit.

A Safe Method of Blasting Chutes

Even experienced miners often use an iron bar for prying loose boulders which have hung up in chutes. If the boulders come down suddenly, the blaster or loader has no time to withdraw the bar he was using and serious injuries frequently result.

How this dangerous practice is avoided at a western mine by substituting specially prepared blasting sticks for iron bars, is told in The Explosives Engineer. These blasting sticks, by means of which a small charge of dynamite is placed in a hung-up stope, pillar, or dumping chute, are cut from a 1-in. plank and are 16 ft. long and 1 in. square. The sticks must be cut from straight-grained material; therefore, carefully sorted straight-grained boards are selected. At this time, where approximately 650 men are employed underground, about 2,500 blasting sticks are used each month. The dynamite is tied to the end of the blasting stick, and the charge is then pushed up into the chute until it comes under the obstruction to be removed. The chute blasters prefer the blasting sticks to iron chute bars, and by using the sticks they do not have to endanger their lives by crawling into the chute. If a boulder falls on the stick it breaks without injuring the user.

Planning Mass Transportation Facilities

Methods of Providing Local Common Carrier Passenger Service in Urban Districts Discussed in Proceedings of Engineers' Society of Western Pennsylvania

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After various factors—present and prospective characteristics of traffic, topography, fares and political relations—have been estimated, plans may be made to apply that type of transportation facility best adapted to each one of the different traffic problems encountered. In a simple problem involving a small community, one type may suffice. In large communities, there are included in the general problem a number of different transportation needs which may require different types of facility for the best general solution.

The different types of transportation facilities to be considered are:

Trackless Vehicles. These include, gasoline buses and trolley buses.

Electric Railways. These include surface street railways, elevated railways for surface cars, subways for surface cars; rapid transit elevated roads and rapid transit subway.

Railroads. These include railroads engaged primarily in through freight and passenger transportation service.

Special Types. Among these may be mentioned, inclines, cable-cars, and moving platforms.

Relative Positions of Various Types.—The relative postions of the bus, surface car, elevated and subway are indicated by the following ratios found by Mr. H. M. Brinckerhoff, a recognized authority on urban transportation:

	Capacity	Speed	Investment	Opeating Cost per car mile
Bus	1	1	1	2
Surface car	1.7	1	2	1.8
Elevated	6	2	12	1.2
Subway	7	2	36	1

From these figures may be derived the relations of operating costs per passenger mile, assuming a full capacity load for all types:

Bus	14
Surface car	7.41
Elevated	1.4
Subway	1

It must be remembered that such statements are very general in their nature and cannot be applied indiscriminately to all situations.

The trackless vehicles have less capacity than street railways, cost more to operate per vehicle mile and require less investment per route mile. The trackless trolley, which requires an overhead electric power distribution system, involves a greater investment per route mile than the gasoline bus, but its operating cost is less. Its capacity is equal to that of the gasoline bus.

The street railway, requiring both power system and track, involves a greater investment per route mile than the trackless trolley, but its operating cost is less and capacity greater.

Elevated and subway terminals for street railway cars reduce operating costs and increase capacity somewhat, but greatly increase investment costs.

The rapid-transit elevated obviously requires much larger investment expenditures. Its operating costs are much less than street railways and its capacity is much greater.

The rapid-transit subway requires a still greater investment than the elevated. The operating expenses are somewhat less, and the capacity slightly greater, than in the case of the elevated.

Railroads engaged primarily in through passenger and freight service must be considered in this problem, but the healthy expansion of their urban passenger service appears most difficult.

Special types of facility, such as inclines, cable-cars, moving platforms, etc., may be adapted to unusual conditions of topography.

The use of an incline to open up the development of an otherwise inaccessible area, by connecting that area directly with street railway or rapid-transit facilities, may be justified in special cases. The disadvantage is inconvenience of bodily transfer between the incline and other types of service. This bodily transfer has been avoided in some instances by operating street-cars over inclines as a part of their route. This method, however, adds a large expense and sharply restricts the capacity of the route

affected. Fifteen cars an hour in each direction is about the limit; and, unless an unusually large incline is provided, the cars must be small and operate in single units.

Cable-cars are rarely used today and are limited to grade conditions beyond the ability of electric cars to negotiate safely.

Sub-surface moving platforms have been seriously suggested for Forty-Second Street cross-town traffic in New York, for the purpose of relieving the streets of pedestrian traffic and providing a convenient by-pass for traffic between rapid transit and other transportation facilities.

Volume of traffic, length of haul, fares, and grade conditions all have a large influence upon the type of facility best adapted to any particular demand for transportation.

The Bus.—The trackless vehicle, requiring less capital outlay than the railway, can be supported by a smaller number of passengers. Its limited capacity, however, restricts its use in the heavy rush-hour traffic of cities. In addition, the flat-fare system generally in use in America restricts its use for long-haul traffic at the usual rate of fare. The increased operating costs per vehicle mile, as compared with rail facilities, wipes out the margin between fares and costs when the average length of ride approaches the average of street railways, at the railway rate of fare. The advantage of investment charges lower than for railway is overcome before the length of haul approaches that of street railways. Abroad, the zone-fare system, which adjusts fares to length of ride, maintains the advantage of low investment charges.

As opposed to this idea, the Fifth Avenue (New York) bus system is often cited as an example of successful bus operation. These buses, however, operate along a densely traveled thoroughfare, a show place for the country, in a city which enjoys the greatest number of visitors of any American city, and where people go to spend money. The total cost per passenger carried in 1921 was 8.03 ct. The traffic carried was 2 per cent of the total mass traffic of metropolitan New York. The rate of fare is 10 ct. as compared with a street railway fare of 5 ct. This operation, which has recently become very successful and prosperous, is unique and cannot be useful as an example of what can be accomplished by motor buses in other cities under conditions of traffic generally encountered.

Field of Trackless Vehicles.—The usual field of the trackless vehicle lies in carrying traffic too light to justify the investment necessary for track construction. There are a number of instances, however, in which buses are doing a profitable business by taking away traffic which has been built up and served by the electric railways.

Popular prejudice against street railways and the impulse to board the first vehicle offering service has furnished considerable traffic for buses. This has been reflected in higher street car fares or inferior street-car service, or both. In some communities a choice between buses and railways, made necessary by unprofitable street-car operation brought about by bus competition, has forced practical elimination of the bus. Des Moines attempted to supplant street-car service by buses. This was done for a time. During that time buses were entirely unsuccessful in furnishing transportation service comparable to that of the street-cars, and the latter have resumed operation with bus competition practically eliminated.

Special service may be properly supplied by buses over long distances in special situations. On the California highways, there are numbers of apparently profitable bus routes. Several street railways are operating buses into undeveloped suburban districts because of the popular demand for such service. Special service is also being rendered by high-speed limousine buses between cities forty to fifty miles apart, with speed greater than on interurban railways and comparable to steam railroad time. One electric railway is operating such service probably on the theory that the short rider between the numerous small intermediate towns on the line is more profitable than the through rider, and that through traffic will be stimulated by faster time and more comfortable service.

The principle field for the bus in urban mass transportation, however, seems for the present to lie in furnishing service for undeveloped sections of the community where the traffic is too light to justify railway construction. There is also an opportunity to use the bus to divert traffic from congested centers and shorten hauls by establishing a bus cross connection between two lines

outside the congested centers.

The futures of the trackless vehicle as a mass transportation agency is more or less vague. The enormous increase in the number of automotive vehicles within the past few years, however, strongly indicates that they may provide service to a greater extent than is at present anticipated.

A total of 5289 buses and gasoline cars are now operated in common-carrier passenger service.

In twelve states and the District of Columbia, 357 trackless vehicles are operated by electric railways.

According to Automotive Industries, there are over 10,000,000 automotive vehicles in this country.

The Automobile as Factor in Transportation.—The importance of the automobile as a factor in the urban mass transportation problem is indicated by the results of a recent survey made in Baltimore. In one day there were movements in and out of the delivery district as follows:

76,234 pleasure automobiles.
37,024 commercial automobiles.
21,036 street cars.
4,224 buses and taxicabs.
13,821 horse-drawn vehicles.

Assuming an average of two passengers for each pleasure automobile, bus and taxicab movement, 365 days in the year, this traffic would amount to about 59,000,000 passengers or 25 per cent of the street railway traffic of Baltimore in 1921.

If a prediction of these facts had been made five or ten years ago, it would have been generally discredited, to say the least.

Advantages and Disadvantages of Trackless Vehicle.—To offset the effect of higher operating costs, there are some advantages in the trackless vehicle over street railway service:

1. It is not seriously affected by many blockades which hamper street railway operation. This flexibility frequently perimts a higher scheduled speed which, in particular instances, may offset its normally higher operating costs.

2. The bus takes on and lets off passengers at the curb, making the service in this particular more attractive.

3. Stopping at the curb, the bus is out of the line of moving vehicles and does not so greatly interfere with other street traffic as does a street-car when it stops to take on or let off passengers. The gasoline bus is also applicable to special traffic movements, which cannot be served on regular routes.

The principal disadvantage of the trackless vehicle, as compared with the street-car, is its limited capacity. It cannot cope with the rush-hour problem of an ordinary American city.

One hundred and fifty street cars (seventy-five two-car trains) would move 12,000 passengers in one direction in an hour on one street. Two hundred and twenty-five platform men would be required. To move this same number by bus would require, in good weather, about 200 buses of the Fifth Avenue type and 400 men to operate them. The element of cost involved in paying the 175 additional men for the rush-hour periods only (one of the grave problems of electric railway operation) shows the unsuitability of buses for this kind of service. The other operating costs of the type of bus required would also be greatly in excess of street-car costs, and for the ordinary length of street railway route on the usual flat rate of fare would more than wipe out profits.

One point regarding the trackless vehicle is the damage to street paving caused by its operation. This cost is now borne by the taxpayer. Street railways, in the past, have been compelled to pay for large amounts of paving not damaged or used up by their service. The bus may, in the future, face the problem of paying for the unusually large depreciation of paving due to its operation.

Electric Railway Service Basic.—There seems to be little room for doubt that electric railways, either street or rapid transit, must form the trunk of any system of mass transportation for cities of any size, and it is becoming increasingly evident that they must be largely used to serve mass traffic, if the advantage of service cheap enough to stimulate community development is to be retained.

The field of the street railway lies between the bus and rapid transit; offering most economical and attractive service for traffic too light to support expensive rapid transit facilities and too heavy, or to expensive on account of length of haul (or both), for the bus.

The maximum labor demand for street railway operations in city rush-hour periods is materially below that of the bus, and is one of the largest elements in preventing the bus from being a real competitor of the street railway in the larger cities. Rapid

transit has a similar advantage over the street railway in low labor demand, but the investment required for rapid transit is relatively much greater as compared with the street railway than the investment for the street railway as compared with the bus.

Street railways generally suffer from an adverse public opinion which is inflamed by annoyances arising from disadvantages inherent in surface street railway operation. Adverse public opinion has, in the past, operated to prevent the proper adjustment of fares to the cost of service, and also other adjustments in facilities and service which would have benefited both the railways and the communities served. This feeling has had a great deal to do with the popular approval of the bus as a competitor of the street-car, and is a factor to be recognized in plans for mass transportation. One of the causes for this hostility has been the interference with street-car operations by other street traffic, bringing about irregularity and vexatious delays. The effect of this interference is aggravated by the inflexible routing which must be followed practically regardless of obstacles. All cars operating over one track are necessarily delayed by a blockade on that track.

Except where safety zones are established, the stoppage of a street-car to take on or let off passengers stops all vehicular traffic in the direction of the car. This aggravates congestion. It is apparent to the users of other vehicles that traffic would be greatly expedited by the elimination of, or a reduction in the number of, street-cars on congested streets; and the feeling undoubtedly exists that by better routing or by separate grade facilities, the street railways could relieve a condition which threatens at least partial paralysis of some important traffic arteries. There is no present complete substitute, however, for the surface street car. Expensive separate grade facilities, which cannot be supported by the street-car rider alone, offer the most effective means for relief. Withdrawing cars from congested streets and routing them over less crowded ones offers a remedy in situations where this amount of relief will meet the requirements. Such re-routing usually involves a withdrawal of the service rendered by long lines, to the edge of the congested district. This creates public hostility and should not be resorted to unless it is offset by a general improvement of the service through more rapid and regular operations. In any rerouting plan, service withdrawn should, if the demand justifies, be replaced to the limits of street capacity by short-routed cars connecting with the re-routed long lines by transfer. Delays to short-line cars in congested streets will not have such a generally demoralizing effect on service as will delays of the same duration to a number of long routes.

To repeat, expensive, separate grade facilities offer the most effective means for relief from street congestion.

Separate Grade Terminals for Surface Cars.—In studying the question of separate grade facilities for surface street cars, due consideration must be given to the condition which, in many cities are rapidly depreciating the value of the service rendered by street railways forced to operate through congested areas on the street surface. Delays to car operation are greatly increasing the cost and decreasing the quality of the service. Increased cost increases fares and tends to drive away passengers. Those remaining must bear a larger part of the cost of service. Depreciated service, also, drives away passengers and increases fares. This product of increasing congestion—increased costs, increased fares, decreased traffic, back to increased costs—certainly presents a striking example of a vicious circle. In order to preserve the indispensable electric railway as a useful facility it may be necessary for the general community to furnish adequate terminal facilities and distribute the burden of cost as nearly as possible in accordance with the benefits derived. The car rider should pay for whatever benefit he derives in the way of decreased costs and improved service. In any event, separate grade terminal facilities for street railways should be given careful consideration in any general plans for large city mass transportation facilities.

It should be borne in mind that there are two types of service performed by separate grade facilities. One, which is simply a terminal for street-cars in the congested district, takes them off the streets, thereby improving the quality and economy of operation of the service affected. The other type, generally adapted only to long-haul traffic, provides large-ca-

pacity, high-speed electric railway service.

Of these two types, the one which simply provides for separate grade terminals for surface street-cars, requires less investment cost, because of its shorter length and less elaborate equipment and station facilities. Rarely, however, can surface car terminal facilities be the economy in operation, stimulation to traffic, or in the benefit to the car rider for which he is willing to pay. The only way in which the large expenditure necessary for their construction in the most expensive location in the community can be justified, is by the general benefit to the community from the reduction in congestion in the central business area and from the speeding up and improvement of transportation service and traffice generally. The speeding up and improvement of transportation produces a real benefit to the population and business institutions affected, inasmuch as it increases the proportion of the whole population from which support for central business activities may be drawn, and makes the service itself more attractive.

Generally, the volume of traffic which can be accommodated in surface street-cars operating in separate grade facilities is not sufficiently great to justify the addition of the interest charges to the fare particularly if a terminal extending considerably beyond the central congested area were required to avoid congestion. The investment cost of elevated railways is one-third that of subways, and they provide almost the same amount of relief.

In this connection, consideration must be given the fact that a rapid transit system which have six times the capacity for traffic that a separate grade street-car terminal would have. If a volume of traffic can be attracted from the street-cars, sufficient to load a rapid transit system to capacity, the principal requisite for that type of facility is supplied, and strongly indicates that the large capacity facility is better adapted to the traffic than the separate grade surface car terminal.

Rapid Transit.—The most effective type of mass transportation facility for consideration is the separate-grade electric railway called rapid transit, on which large cars are operated at high speed. Its principal advantages are large capacity, high speed and low operating cost. Its disadvantage is high investment cost. This disadvantage is not so great in the case of the elevated railway as in the case of the subway, which the advantages of large capacity and high speed are not so greatly in favor of the elevated as of the subway. Express tracks and loading facilities for elevated railways are not so readily provided as in the case of subways.

Public antipathy to elevated railways should not prevent the construction of such facilities where justified, if financial considerations prevent subway construction. The general advantages from better and more nearly adequate transportation service which can be rendered by elevated railways, offset their defects. Philadelphia has recently completed an up-to-date, elevated, rapid-transit line between Philadelphia and Frankford. The enormous benefits to be derived from such a facility would seem to counteract all its disadvantages.

A large volume of traffic considerably in excess of the utmost capacity of all of the other types of facilities available, is the prime requisite for a rapid-transit system. Interest charges upon the large investment necessary must be spread over a large number of individuals deriving benefits from the system. Passengers on rapid-transit cars are not the only beneficiaries, but, unless they are numerous, there will not be enough of general benefits to justify the necessary heavy expenditure.

Rapid-transit systems generally may be expected to double the speed of service. This means a large increase in the distance and territory within which the population of the district served may support its industries and institutions. If the rapid transit serves under-developed territory in a growing district, it will stimulate the development of that territory for the use to which it is best adapted.

As stated above, in those communities in which development is practically unobstructed by topographic conditions, such as rivers, hills, ravines, etc., the dispersion of population in all directions from the central business area prevents concentration of enough traffic in a single artery to justify expensive rapid-transit systems. Chicago is an example. In such communities, not only is the demand for transportation distributed over a large number of arteries, but the comparatively short distances and

correspondingly short time between traffic centers reduces the general demand for faster transportation.

On the other hand, in some communities the development of industrial, commercial and residential areas, together with the number of connecting highways, has been restricted to topographic conditions. Development has naturally taken place in the restricted areas best adapted, at favorable points along the limited number of highways. Congestion in these highways has brought a heavy demand for passenger transportation service to relieve them and permit the orderly adjustment of housing, industrial and commercial developments in areas best suited for their respective purposes. This demand for transportation, concentrated in a few highways leading in the same direction, has resulted in a heavy volume of traffic justifying the construction of expensive facilities. The distances between neighboring traffic centers, increased by the restrictions of development, has undoubtedly augmented the general demand for transportation. In this way, by proving a concentrated demand for passenger transportation capable of being supplied by a single artery, topographic conditions work to the advantage of expensive rapid-transit systems. The more congested the few highways become, the more insistent becomes the demand for relief which in large quantities can be afforded only by a rapid-transit facility of large capacity.

If a system could be designed to connect adequate areas, developed and suitable for development for industrial purposes, with adequate areas devoloped and suitable for development for housing purposes, there could be no question but that the passenger traffic now moving between those areas would avoid the slow and, in some cases, tortuous movements around natural obstacles and flow through the rapid-transit system.

The diversion of passenger traffic from the more expensive service rendered by facilities other than rapid transit, would effect economies which would partially offset the larger investment necessary.

Relief of the other arteries of traffic would ensue. Adjustment of development, by the release of territory adapted to industrial use through the removal of residents to areas better adapted to housing development, would be stimulated and would in turn create new traffic for the mass transportation facilities.

New York (Manhattan Island) is the most striking example of how traffic is affected by restricted expansion, stimulated by a rapid-transit system. Restricted in all directions except to the north, with distances between traffic centers creating a strong demand for fast transportation facilities and with its few traffic arteries taxed to the limit, the opening of rapid-transit outlets for this traffic has always brought a rush taxing their great capacity.

Rapid-transit facilities, by themselves, cannot be made as valuable to a community as if co-ordinated with other types of transportation. If buses, street-cars and rapid transit were all competing for the same business, service would be duplicated and all three types would probably operate at a loss. If, however, the buses were used as a feeder to the railways or rapid transit, carrying short-haul traffic too light for railway investment, and turning the long-haul passengers over to the rail facility; and, in the same way, if the street railways were used to carry traffic too heavy for buses and too light for rapid transit, feeding to the rapid transit long-haul traffic, which would be unprofitable for the surface car, duplication of expensive service could be avoided. Unnecessary traffic movements could be avoided by transfers and by-passes over auxiliary facilities short of congested centers. By this co-ordination, the best results for the community in good transportation service at the lowest possible rate could be most nearly accomplished.

Conclusions.—The mass transportation facilities of any urban district are vital factors in the life and progress of that district. They must be adjusted in capacity and extent to the present and prospective development of the community served.

Natural resources, external transportation facilities and topography are the principal material bases limiting community development.

The principal object in planning mass transportation facilities is to provide for transportation service in and between industrial, commercial and residential areas, which will stimulate, to the degree justified by present and prospective conditions, the properly co-ordinated development of these areas for that use to which each is best adapted.

Another important object is to provide for transportation service which will stimulate the orderly development of educational, religious and amusement institutions and central community activities, by making them available to the whole population.

Mass transportation facilities for an urban district should include those types best adapted to the different traffic problems usually encountered in such a district.

Generally:

Trackless vehicles are best adapted to light-volume, short-haul, high-fare traffic.

Street railways are best adapted to medium-volume, medium-haul, medium-fare traffic.

Rapid transit (high-speed, large-capacity, separate-grade electric railway) is best adapted to large-volume, long-haul, low-fare traffic.

Planning a mass transportation system involves the co-ordination of these types of facilities so as to apply to particular traffic movements the most economical and attractive type.

The various types of service must be auxiliary and supplemental to each other and not directly competitive.

No general plan for the large expansion of mass transportation facilities should be decided upon until after the most comprehensive and exhaustive investigation by engineers of experience in the design, construction and operation of all types of facilities.

Due consideration must be given to plans for community development adopted by representative bodies.

The importance of the problem and the consequences for good or evil to the community, which may result from good or bad planning for this vital service, demand the constructive interest and co-operation of representatives of all the interests of the entire community; social, political and business.

$2,000,000 Branch Railway in Mexico.—A decree has been signed authorizing the Secretary of Communications of Mexico to expend the amount necessary for the construction of a railroad branch line to run from the station of Beristain, the state of Hidalgo, on the Hidalgo and Northestern Railroad to Fobero in the State of Vera Cruz. The line is to be 140 kilometers in length and the cost is estimated at $2,000,000.

Automobile Grade Crossing Accidents

Extract from Presidential Address Delivered June 13 at Annual Meeting of Amercian Association of Railroad Superintendents

By W. S. WILLIAMS,

General Superintendent of Illinois Central Railway Western Lines.

A subject of great importance today, which I think should be given careful consideration and attention by our association, is the prevention of grade crossing accidents. For the six year period ending Dec. 31, 1922, there were 21,902 automobile grade crossing accidents reported to the Interstate Commerce Commission, in which 9,849 persons were killed and 27,349 injured. The death cases do not include those who died from injuries over 24 hours after the accidents occurred.

Experienced railway men, who have made a study of the subject, claim that automobile grade crossing accident statistics prove that the crossings considered the most dangerous are actually the safest. In other words, that the majority of the accidents occur at the outlying crossings where trains are not expected, and that comparatively few accidents occur at the crossings considered the most dangerous. That, of course, is because automobilists use more care for their own safety at the dangerous crossings.

Experienced men also claim that a bad accident in a community in which lives are lost, or people are seriously injured, is invariably the signal for a great hue and cry in that community for the elimination of the crossing where the accident occurred, or the protection of it by gates or electric warning bell, or a cross watchman.

Crossing gates do not entirely eliminate accidents for the reason that people become educated to rely upon the gates instead of upon their own faculties. If the man in charge of the gates errs, or if the gates get out of order, the danger of accident is very great.

Electric warning bells do not entirely eliminate accidents. If they ring a great deal automobilists disregard them. In addition to that, there is always the possibility that the bell may not be in order just at he moment of greatest danger.

Crossing flagmen are not infallible. The human element enters into most

accidents in one way or another, and crossing flagmen are like other human beings. Some of the very worst automobile accidents that have occurred have been at crossings where flagmen were on duty.

One of the effects of so-called crossing protection is to teach the public that the crossings are safe when, as a matter of fact, the opposite should be taught.

It is clear that the policy of the past of trying to place the responsibility for safety at railway grade crossings upon the railways has not accomplished the desired results. It has not prevented automobile grade crossing accidents. There is no definite way of telling whether it has even tended to reduce them.

The grade crossing problem is usually considered from two viewpoints—that of the railways on the one side and that of the public on the other side. There is also the viewpoint of engineers and firemen, which has been almost entirely overlooked. At best their duties are nerve-racking, and the habit of automobilists in racing to crossings and darting upon the track immediately in front of the locomotives has a great tendency to shatter the nerves of these men. They ought to have some assurance that an automobile will be brought to a stop before it is permitted to cross a railway track.

Reduction in the number of grade crossings by the relocation of highways should be considered wherever practicable. In plans for new highways, railway crossings should be avoided as much as possible. That this has not been done in the past is evidenced by the fact that the new hard-road trails seems to have been laid out and constructed without much thought as to railroad grade crossings.

1. The adoption of a program for the gradual elimination of grade crossings, the expense to be borne by the tax-payers and the railways in proportion to the benefits received—this program to become effective immediately following the necessary enlargement of terminals, improvement of roadways and acquisition of sufficient equipment on the part of the railways to enable them to take care of the traffic demands.

2. Re-location of highways where by so doing it may be possible to reduce the number of grade crossings.

3. Avoid the crossing of railways as much as possible in plans for new highways.

4. Require the railways to install and maintain proper warning signs at railway grade crossings.

5. Require railway property at grade crossings to be kept as free as possible from obstruction to the vision.

6. Require counties to remove all obstructions to the view, such as trees, underbrush, and unnecessary buildings, and other obstructions located on private property near railway grade crossings.

7. The passage and enforcement by municipalities and the States of proper "Stop, Look and Listen" laws.

8. Teach everybody, commencing with the children in the schools, that railway grade crossings are extremely dangerous—the "protected" as well as the unprotected crossings.

9. Educate the public in regard to the inability of the railways to eliminate all grade crossings and the unfairness of some communities insisting upon the railways doing things for them that cannot be done for all.

10. The launching of a great crusade, having the backing of the state governments, against careless driving of automobiles, particularly at railway grade crossings.

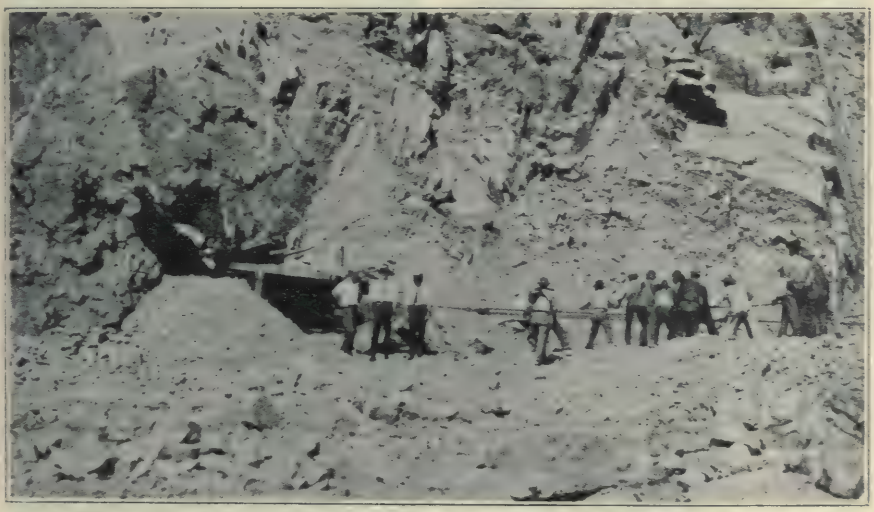
I know we all agree that something will have to be done, and that soon, to materially reduce grade crossing accidents. This, again, is a problem that is daily confronting the division superintendent more than anyone else, and I feel it is a proper subject for active handling by this association. We are represented by membership in every state in the Union, and our concentrated efforts should go a long way toward having suitable laws enacted which will greatly reduce, if not entirely eradicate, these uncalled-for accidents. Some states have already enacted laws requiring automobiles to stop before crossing over railway tracks, and I personally favor this method more than any other. At the present time a "Cross Crossings Cautiously" campaign is being carried on throughout the country under the auspices of the American Railway Association, and, until some more effective method can be adopted, I want to urge the members of this association to lend their best efforts toward making this campaign a success.

Tunnel or Coyote Method of Blasting

When It Should Be Used and the Proper Procedure Under Varying Conditions Described In The Explosives Engineer

By J. C. CUSHING

During the past 10 years I have made 300 or more tunnel or so-called "coyote" shots. I can safely say that no two have been loaded alike, and to have used the same methods in every shot would have been a most serious error. However, the knowledge obtained from making each of these blasts has helped in figuring the succeeding ones more scientifically. The problems encountered in "coyote" hole shooting can be grouped under a number of general heads, and if each of these points is considered separately there is much greater assurance of successful results.



Loading a Coyote Hole. On This Blast 50 Tons of Explosives Broke Down 365,000 Tons of Rock.

Factors To Be Considered for Tunnel Shot.—In loading a well-drill shot, you can nearly always figure on a certain amount of explosive to the yard with only slight deviations, depending upon the hardness or specific gravity of the formation; in loading a tunnel shot there are at least five factors to be considered.

The first point to decide is whether or not the tunnel method can be used in the formation to be blasted. If the rock lies in horizontal planes, tunnel blasting is decidedly not the best method. The risk is too great, and the amount of explosive necessary is so much in excess of other methods that the cost is prohibitive. To obtain good results from tunnel blasting without taking too much risk, the rock should occur in mass formation or in vertical strata, and should not be too seamy.

After the practicability of tunnel blasting has been established the question arises whether or not the cost of drilling and back-filling the tunnels will increase the cost over other methods. Several points must be considered in deciding this. If the surface of the ground is uneven, and it is difficult and expensive to move the well-drills around, tunnel blasting is usually advisable, or if the material is very seamy, which makes well-drilling unduly expensive, conditions are favorable for tunnel blasting.

The third consideration is the desirability and importance of a uniform back-break. An even back-break is one of the principal advantages of well-drill blasting with column loading, and when from the nature of the material it is impossible to get a uniform

back-break, a possible objection to the tunnel method is eliminated.

Another point to be considered is the height of the bank. Obviously, in a low bank the cost of tunnel driving is excessive because of the small amount of material displaced. For successful tunnel blasting the bank has to be higher than the length of the main tunnel, because in tunnel shooting sufficient explosives are loaded to kick out the bottom of the toe, which permits the over-lying material to fall in and to break into small pieces while falling.

The size of rock obtained by the various practicable methods should also be studied. If the material in the bottom of the ledge can be readily broken into small pieces, while that in the upper strata is likely to break unusually large, I would hesitate to adopt the tunnel method, providing well-drilling could be used; because in tunnel blasting the explosives charge is all in the bottom, while in well-drilling the charge can be more or less distributed throughout the entire mass. Therefore, in most cases the rock can be more uniformly broken up by column loading in well-drill holes. However, if a steam shovel of large capacity is available this point is not so important, but if the material is to be loaded by hand or by small shovels it is decidedly important.

Considerations Governing Choice of Explosives.—Assuming that all of these factors have received careful consideration, and it has been decided to adopt the tunnel method, the next step is to choose the proper grade and strength of explosive. There are at least three factors to be considered.

First, is it desirable to throw the rock a considerable distance out on the floor? If so, a low explosive such as black blasting powder or R. R. P. should be selected. If, on the other hand, it is desired to break the rock as small as possible without throwing it too far, dynamite should be used and the loading pockets placed closely together.

The second question is: how is the material to be handled after blasting? If large power shovels are used, a lower grade of explosive can be adopted as little secondary blasting will be required. If, on the other hand, the loading equipment is small or the material is to be moved by hand, a higher strength explosive is necessary, because in tunnel blasting, as in other methods, the quicker explosives break up the rock into finer pieces.

The third important question is whether the material is so seamy or so broken up as to make this method more or less risky, particularly if black blasting powder is used. In some instances, the material is so seamy that there is a possibility of one or more of the explosives charges blowing out along the seams. Black powder is particularly apt to do this. This tendency can often be overcome by loading all of the powder below the floor with tamping between the powder and the roof inside the tunnel. The gases then work directly into the tamping before reaching the seam, and this slight delay gives them an opportunity to work against the rock itself and weaken the mass at other points, before the force of the explosion escapes through the seams. With R. R. P. of 5 per cent strength, which is generally used in large tunnel blasts in the West, there is much less likelihood of a blown-out shot, because the rate of detonation of R. R. P. enables it to throw out the toe before the gases escape through seams, and it is usually not too fast to prevent its loosening the upper strata before the gases have been entirely expended in moving the toe.

Proper Length of Tunnels and Cross-Cuts.—After deciding upon the best explosive to use, the next step is to determine the proper length of the main tunnel and cross-cuts. The ideal tunnel is one which penetrates the bank to a distance of about two-thirds of the height. However, it has been my experience where only one cross-cut is to be used, that to insure the toe being well broken up and thrown out on the floor, it is impracticable to have the main tunnel more than 60 ft. long. Where the bank is higher and the amount of explosives that can be used is not limited, several crosscuts can be driven; but best results at least cost are obtained by using the shorter tunnel and the single cross-cut. The length of the cross-cut is determined by the amount of material to be displaced, and also by the surface conditions of the quarry face.

Several years ago I made a 50-ton shot in a bank 215 ft. high, in which I used two tunnels, each 140 ft. long, with three cross-cuts 150 ft. long from each tunnel. The first cross-cut was 40 ft. back from the toe, the second 90 ft., and the third was at the end of the 140-ft. main tunnel. The results

from this shot were quite satisfactory.

Size, Number, and Location of Explosives Charges.—It is difficult to give any formula for computing the amount of explosives necessary, as conditions are different for each shot. A fair way to compute an average amount is to determine the yardage in the section included by the cross-cut and vertically over it, and to load about one pound of explosives to the cubic yard of material when using a low-grade dynamite and slightly smaller amount when loading with a dynamite of higher strength. If the explosive is to be black blasting powder a good average is about 1½ lb. to the cubic yard. Actually, greater yardage per pound of explosives is obtained in the blast, but this is the result of the back-break and side-break and varies according to local conditions.

The next point to decide upon is the number, location, and size of the pockets to contain the powder charges. The number varies with the surface conditions and grade of explosive used; that is to say, you will ordinarily require fewer pockets with a low-grade explosive than with a high-grade one, surface conditions being equal. The location of the pockets is determined by surface conditions, and the size of the pocket is determined by the charge it is to contain. The pockets are usually drilled below the floor of the cross-cut. This distance is generally obtained by figuring on 1 ft. below the floor for each 10 ft. of toe in front of the pocket. If the bank is nearly vertical it is not necessary to drill so far below the floor.

Opinion varies as to the most economical size for the tunnels. I believe that what is known as the "wheelbarrow" size is the most economical. This is a tunnel about 3 ft. wide and 4 to 5 ft. high; it gets its name from the fact that a man can readily operate a wheelbarrow in taking muck in and out of the tunnel. Larger tunnels are an unnecessary waste and smaller ones make drilling, loading, and back-filling an awkward and tedious operation. When the tunnel is driven by hand methods, the cost varies according to the skill of the labor employed. The average cost for a tunnel of the wheelbarrow size, where compressed air is used for drilling, is approximately $5.00 per linear foot. The cost of back filling a tunnel of this size is on an average about $1.00 per linear foot. The best material for back-filling is the rock which came out of the tunnel when it was driven. The first tamping for a depth of about 6 in. to 1 ft. should be fine sand. This prevents the powder from being ignited by sparks during the back-filling.

The Methods of Firing.—Either series or parallel connections can be used for detonating the blasts. If the shot is to be fired with a blasting machine, it is, of course, necessary to wire in series. However, whenever there is sufficient current available, tunnel blasts are usually wired in parallel and from two to three detonators are placed in each powder charge.

The main wires are usually fastened to the roof of the tunnel where they are least apt to be broken during back-filling or by the weight of the tamping itself. A good method is to drill short holes in the roof approximately every 20 ft.; and to drive wooden blocks in these holes. The wires are then fastened to these blocks.

Forty per cent dynamite is generally used for the priming charge. In most cases the dynamite priming charge is approximately 5 per cent of the total load of R. R. P. or black blasting powder in the pocket. The blasting caps are embedded in the dynamite, which is in turn placed in the center of the charge.

When sufficient current is not available for electric firing, cordeau can be successfully used. The cordeau is run through the main tunnel to the first powder charge, then through each succeeding powder charge, and back through the main tunnel to the surface. The cap is then connected to each end of the cordeau at the mouth of the tunnel. This affords double protection against misfires. However, I recommend electrical firing wherever possible because of the difficulty in protecting the cordeau when back-filling the tunnels.

Testing of Explosives.—Tests are being made by the Department of the Interior at the Pittsburgh experiment station of the Bureau of Mines to determine the temperature at which various explosives will detonate or flash. A series of tests has just been completed to show the effects of crystal size and method of purification on the strength and sensitiveness of T. N. T. Apparently both factors have some effect on the explosive properties of T. N. T., but the variation is within narrow limits.

Construction News of the Railways

Surveys Underway for S. P. Cutoff in Oregon

New surveys are reported being made by the Southern Pacific Co., over the summit of the Cascade Mountains for the Natron extension into Klamath County, Oregon.

I. C. to Spend $500,000 at Council Bluffs, Ia.

The Illinois Central R. R. has plans for the expenditure of $500,000 in improvement of the Council Bluffs yards, including expansion from avenue B to Big lake, and construction of a new 18-stall roundhouse and concrete coal chutes, with cinder pits and automatic conveyors. At least $300,000 will be spent upon the extension of the yards alone, with the construction of new tracks, which will increase capacity by 100 per cent.

To Improve Hudson Bay Railway

The Canadian Parliament has authorized an appropriation of $350,000 for betterment on the Hudson Bay Ry.

B. & O. Lets Contract for Pier Repairs

The Baltimore & Ohio R. R. Co. has awarded a contract to Armstrong & Latta, Philadelphia, for repairs of all its piers on the Delaware River at Philadelphia, and the construction of a new freight float at Pier No. 62. This work will cost several hundred thousands of dollars. The same firm is making repairs to some the Pennsylvania R. R. Co. piers on the Delaware.

Work to Be Started Soon on Moffatt Tunnel

Work on the new tunnel through the Continental Divide on the Moffatt road to be built by the of Colorado at a cost of $7,000,000 will start late this summer.

Canadian Railways to Spend $28,000,000

The construction program of the Canadian National Railways calls for a total expenditure of over $28,000,000. Out of the total nearly $18,000,000 will be expended in the Prairie Provinces, over $3,000,000 in British Columbia, nearly $5,000,000 in the Maritime Provinces, about $2,000,000 in Ontario, and less than $500,000 in Quebec.

N. P. to Construct 30 Mile Line in Montana

Authorization to construct a branch line 30½ miles in Rosebud County, Montana, to the Rosebud coal fields where the Northern Pacific R. R. proposes to mine coal for its own use has been granted the road by the Interstate Commerce Commission. The route branch line does not pass through any town or village. The commission requires that work be started not later than September 1 and completed by July 1, 1924. The road was denied permission to retain the excess earnings. The branch line will cost $1,493,310.

New Texas Road to Resume Grading

According to reports from Fort Worth, Tex., work on the Stamford & Eastern R. R. will be resumed. The company was grading in 1917, but was stopped by war conditions. The line to run 145 miles, between Stamford and Fort Worth.

O. S. L. to Build 11 Mile Line in Idaho

The Oregon Short Line has been authorized by the Interstate Commerce Commission to proceed with the construction of an 11 mile branch running from Ammon to Dumas, both points in Idaho to provide transportation facilities for irrigation projects.

Construction Underway on Mexican Line

Construction of 98 miles of railroad in Mexico by the Southern Pacific R. R. of Mexico will be financed temporarily from the treasury of the Southern Pacific Co. This improvement, which, it is expected, eventually will be paid for out of funds to be turned over by the Mexican Government in settlement of claims for more than $13,000,000 made by the railroad, will cost between $8,000,000 and $10,000,000. The purpose of the construction is to connect the present line of the Southern Pacific with the National Railways of Mexico and complete a route between the United States and Mexico City. Fifteen miles of the line is being constructed by the railroad itself, and contractors are building about 85 miles from La Quemada to Tepic. All this work is well under way and progressing from both ends.

D. & Rio G. Ry. to Spend $2,719,000

Improvements amounting to $2,719,-700 are to be made by the Denver & Rio Grande Western R. R. at its shop facilities at Denver, Pueblo, Salida, Grand Junction, Alamosa and Salt Lake City.

Northwestern Spending $5,000,000 for Improvements

The Chicago & Northwestern Ry. has improvements underway that will involve an expenditure of approximately $5,000,000. In Chicago a third main track is being laid from Elmhurst to West Chicago. An addition to the Ravenswood Chicago office building, four stories in height, is under way. Grade elimination on the Madison division at Layton Park, Milwaukee, is being carried out. This work consists of elevation of tracks for a half mile and depression for two miles, involving three subways, eight viaducts and about one mile of concrete retaining walls. Eleven grade crossings will be eliminated. A new station and team-yard at Layton Park will be built in connection with this improvement. Modern mechanical coal chutes are being erected at Chicago shops and at Milwaukee, Belle Plaine, Tama, Evansville, Huron, Waseca, Antoine and Stambaugh, to replace old types of coal plants. The increase in the production of petroleum products in Wyoming has made necessary extensive track and yard improvements at Casper. There is also being built at Casper a 10-stall modern engine house and 95-ft. turntable.

Contract Let for 8-Mile Logging Railroad

Siems & Carlson Co., Spokane, Wash., has been awarded a contract by the Rose Lake Lumber Co., for the construction of an 8-mile logging railroad from Pritchard, Wash.

Atlantic Coast Line to Build 46 Mile Railway

Permission has been given the Fort Myers Southern R. R., a subsidiary of the Atlantic Coast Line, by the Interstate Commerce Commission to build a 46-mile stretch of new railroad down the western coast of Florida. The line will be a southern extension of the present Atlantic Coast Line and will run from a point at or near Fort Myers through Bonita Springs to Marco. The company proposes to complete the line this year.

L. & N. Awards 17 Mile Contract

The Nichols Contracting Co., Atlanta, Ga., has been awarded a contract by the Louisville & Nashville R. R., for 17 miles of second track between Baileys and Walls End, Ky.

U. P. to Spend $3,000,000 on Development at Kansas City, Kan.

Expenditures aggregating $3,000,-000 will be made as the first step in the improvement program outlined by the Union Pacific R. R. Co. in the Fairfax drainage district, Kansas City, Kan. Prospective additional improvements, officials said, would aggregate $10,000,000. The major development contemplates approximately 16 miles of streets, 65 ft. wide; 5 miles of main artery streets 85 ft. wide; 32 miles of switch tracks; electric lights to connect with the Kansas City, Kan., municipal plant; sewers, gas mains, drainage ditches, and five miles of dikes around the river front.

O. S. L. to Build 22 Mile Line

The Oregon Short Line R. R. has taken bids for constructing 22 miles of line between Orchard and Perkins, Idaho.

B. & L. E. R. R. to Build New Dock at Conneaut, O.

The Bessemer & Lake Erie R. R. has opened bids for the construction of a $3,000,000 dock improvement at Conneaut, O.

Santa Fe to Spend $600,000 at Dallas, Tex.

The Santa Fe R. R. will build railroad tracks between the main line of the railroad and the cement and oil plants in West Dallas. An expenditure of $600,000 is proposed.

New Interurban Line at Houston, Tex

The Seaboard Electric Ry. Co., according to reports will start construction Oct. 1, on its new line. This company, incorporated with a capital stock of $2,000,000 proposes to build and operate an electric interurban railway from Houston via Harrisburg, Pasadena, San Jacinto battle park, Morgan's Point, along the ship channel, and thence along the bayshore to Seabrook. I. A. Cottingham, for many years chief engineer of the Atlantic system of the Southern Pacific lines, is the engineer in charge of the location and construction of the proposed interurban.

M. C. Lets 5-Mile Yard Contract

The Dominion Construction Co., East Toronto, Ont., has been awarded a $500,000 contract by the Michigan Central Ry., for the construction of 5 miles of new sidings at St. Thomas, Ont., yards.

Logging Railroad Construction Near Kelso, Wash.

Active construction of the Hammond Lumber Co.'s railway eastward from Kelso, Wash., is now in full swing all along the line. Copenhagen Bros., who have the contract for grading of the east end of the line, have established their camp and started work a few days ago. A. A. Brynes, who has the contract for construction of 35 bridges and trestles on the line, has completed the first bridge and is working on the second. The Hammond Co. will raise and widen the dike, which will be used as a right of way. They have decided to do this work with a steam shovel and train distribution instead of with a dredge.

New York Central Improvements at Bellaire, O.

The New York Central R. R. Co., has acquired 25 small tracts in the Nickel Plate district east of Bellaire, O., in furtherance of the company's vast yard improvement project.

Pennsylvania R. R. May Build Canadian Line

It is reported that the Pennsylvania Ry. is planning the construction of a line from Bridgeburg to St. Thomas, Ont., where it will link with the Pere Marquette.

New Terminal Facilities Proposed for Cincinnati

A new railroad terminal and a new union station for Cincinnati, O., is proposed by the Cincinnati Railroad Terminal Development Co., organized last week. The development company, incorporated with a capital stock of $250,000, practically all of which has been subscribed, has the following officers:

President, George D. Crabbs; Vice-President, John Omwake; Secretary, Robert A. Taft; Treasurer, Maurice J. Freiberg. It is stated that engineers will be secured and plans developed for a project that may call for an expenditure of $50,000,000.

Chicago & Joliet Electric to Relocate Line

The Chicago & Joliet Electric Ry. Co. will relocate its tracks between Lemont and Argo, a distance of 13 miles, providing permission is granted by the Illinois Commerce Commission. Application for the permit has been filed asking that the company be allowed to locate its traction line near the right of way of the Chicago & Alton R. R., between the two cities. Options on the rights of way have been obtained and the work can be started this summer, according to J. R. Blackhall, general manager of the electric line, who estimated the work would cost approximately $400,000.

Alaskan Railroad Extension Proposed

The Alaska Anthracite R. R. is planning an extension that will, it is stated, quadruple shipping facilities from the Bering river coal fields to the water. The banking firm of Harris, Ayres & Co., New York City, is understood to be financing the project.

A $78,000,000 Transit Development for Philadelphia

Suggestions for additions to Philadelphia's high-speed transit system, making some important changes in existing plans, have been presented to the Councilmanic Transit Commission by engineers for the city, the Philadelphia Rapid Transit Co. and central business interests. The first unit of the recommended plan calls for a two-track subway under Broad street southward from Olney avenue to McFerran street, thence a four-track tube as far southward as Ridge avenue.

From there a two-track subway would continue to Spruce street, and another two-track subway from Broad street and Ridge avenue would run down the Ridge to Eighth street, thence under Eighth street to Walnut, westward on Walnut, crossing the Schuylkill by a bridge or tunnel. An elevated railway in Woodland avenue from the neighborhood of the University of Pennsylvania campus at Thirty-fourth street to Darby is another link in the suggested lines. The grand total cost is placed at $78,000,000, of which sum $50,050,000 will be spent for structure, $3,830,000 for track work, $5,890,000 for equipment and $12,230,000 for cars.

Unusual Culvert Construction On Castleton Cut-Off

One of the heaviest and most difficult pieces of earthwork on the Castleton Cut-off of the New York Central R. R., south of Albany, N. Y., is on the connection to Ravenna to replace the present Albany branch of the West Shore Line. This construction includes the crossing of Creyman's Creek on a fill about 75 ft. high. This crossing involved a difficult culvert problem, which was solved in the matter noted below, the description and illustration being taken from the Railway Age.

The creek is subject to heavy overflows in the spring and the soil of the valley is of a treacherous and unstable nature. Measurements of the maximum flows indicated that an opening equivalent to a 50-ft. arch would be needed. However, because of the soil conditions at this point necessitating the use of piling, plus the height of the fill, the loading for a span of this size and likewise for two spans of an equivalent opening were prohibitive. It was, therefore, decided to erect a structure which would permit safe loadings and likewise be of such a construction that any possible failure due to uneven settlement, shifting, etc., would be obviated. The type of structure utilized consists essentially of a large reinforced concrete box culvert having three openings approximately 15 ft. wide by 22 ft. 6 in. high and overall dimensions exclusive of wing walls of 224 ft. by 71 ft. This culvert was loaded to one side of the existing creek bed, at right angles to the center line of the track and in a position to form a straighter flow of water through the ravine at this location.

Uniform bearing was secured by pouring the bottom of the culvert as a reinforced concrete slab, 3 ft. 9 in. thick for the full base area of the structure and carrying it upon piles driven on 3-ft. center. The bases of the side and intermediate walls were constructed of mass concrete keyed to the base slab and to the upper wall sections. The roof slab had a minimum thickness of 3 ft. and was heavily reinforced and tied in to the upper sections of the side walls. The method of construction was about as unusual as the structure itself. Because of the instability of the soil and the seepage of water, the area to be covered by the structure was entirely enclosed with interlocking steel sheet piling. The soil was then excavated to well below the base of the concrete slab after which piling were driven on three feet centers each way except at the ends of the culvert where it was driven only under the haunches and retaining walls. All piling was then cut to the grade of the invert and cinders filled in between them and well tamped up to within three inches of the top of piles. Reinforcement was next placed and the 3-ft. 9 -in. slab poured, followed in turn by the side walls and the top slab. The sheet piling will be left permanently in place to form a retaining wall against possible disturbing soil actions. The flow of water is thus carried through the culvert entirely separate from any contact with any of the supporting soil and a maximum prevention of a possible soil saturation is secured.

Driving the Piles to Support the Culvert at Creyman's Creek.

Accidents in Handling Explosives

Investigations conducted by the Department of the Interior through the Bureau of Mines relative to the hazards involved in the handling of explosives indicate that the number of accidents in handling and testing explosives is relatively low; in fact, it is lower than in some supposedly less dangerous occupations. Workers who handle explosives, being aware of the danger, practice carefulness until it becomes a habit; in consequence accidents are relatively few.

Any feeling of nervousness by a man engaged in handling explosives is highly dangerous, as it may result in his dropping a batch of sensitive material or knocking over a piece of apparatus. Men subject to nervousness should overcome it or get out of the industry. All explosives should be treated with proper respect, but it is not necessary to feel that the slightest jar will be disastrous.

The Bureau of Mines estimates that at least 75 per cent of all the industrial accidents with explosives are caused by hurrying the work and by taking chances where conditions are known to be dangerous; probably 20 per cent are due to carelessness, the rest having at least fairly excusable causes. The great essential in avoiding accidents is that inexperienced men should be made fully conscious of every movement in handling explosives and should be trained to "play safe" until they are automatically careful all the time.

Passing the "Buck" to the Roadmaster

In an interesting article in the Railway Review on the railways of India E. S. Rice of the Santa Fe system, relates the following:

At Trichinopoly, the week before we arrived the depot was overrun with monkeys. One little fellow got in through the ventilator and did such things to the agent's desk that it will take him a month of Sundays going to confession to get over the cussing the monkey caused. Now here come in the boys to whom I have always maintained they come when all else fails—the engineers! Of course no one else could suggest a remedy, but the engineers were used to blind tigers, etc., so they spread a trap and caught a whole box car full of monkeys. Then again they demonstrated the fact that they know what to do in an emergency. They shipped them down to the next division, where they didn't like the roadmaster, and they had their reward double—first by cleaning up the pest in their own station and then getting even with their hereditary enemy, the roadmaster.

New Atlas Gelatin

The improved gelatin recently placed on the market by the Atlas Powder Co. is reported as giving excellent results. One foreman advises that his men have reduced the number of sticks to the hole and have stopped three fans as gas is no longer troublesome. A resident engineer on a large tunnel reports that his men could return to work in 12 to 18 minutes, which with old-style gelatin it required at least 30 minutes before the men could return, and then they could not stay. In addition to these advantages, the manufacturer advises that the new explosive is extremely high in water resistance and also practically perfect in plasticity.

Street Railway Paving at Los Angeles, Cal.

In a discussion last fall at a conference at Philadelphia of city and street railway engineers, J. A. Griffin, City Engineer, Los Angeles, Calif., gave the following information regarding the practice in his city.

The franchise or permit to use the street that is issued to the railway company contains a clause that they shall install and at all times maintain the same type of pavement on their right-of-way, which extends from 2 ft. outside the outside rail of one track to 2 ft. outside the outside rail of the other track, as is used on the balance of the street, unless special permission is granted to do otherwise. This method works out very well and practically no friction occurs between the street railway corporations and the city. In some instances where extensive paving programs have progressed very rapidly, the railway companies were unable to pave their portion at or near the same time the other portions of the street were paved, but in each such instance they altered the grades of their tracks and covered the dirt surface with screenings and oil to make their portion passable until such time as they could follow with permanent paving.

Buildings

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.

221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*

LEWIS S. LOUER, *Vice-President and General Manager*

New York Office: 904 Longacre Bldg., 42d St. and Broadway

RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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Vol. LX. CHICAGO, ILL., JULY 25, 1923 No. 1

Prospective Wages and Prices in the Building Field

Wage rates in the building trades are approximately 80 per cent above the pre-war level, and the average price of building materials, other than steel, is approximately 100 per cent above the pre-war level. The price of structural steel is about 60 per cent above the pre-war average.

Since labor constitutes about half the cost of the average building, the average building costs about 90 per cent more than in 1913 where labor efficiency is the same as it then was. Our per capita gold is nearly 90 per cent above the 1913 amount, which leads us to anticipate that our average wages will gravitate toward a level about 90 per cent above that in 1913; for during the past 80 years our wage levels have always followed our per capita money levels, and our per capita money has long tended to oscillate about a level that was twice the per capita gold.

The safest prediction that can be made is this: So long as America retains the four billion dollars of gold that it now possesses, we may expect to have a wage level approximately 90 per cent above that in 1913; and in any business where efficiency of production has not changed appreciably since 1913, we may expect to see the prices of products gravitate to a level about 90 per cent above the price level of 1913.

In the building trades there has been no marked change in efficiency of production as compared with that in 1913. We may therefore infer that there is nothing abnormal in the present level of building costs. Abnormality of price levels exists only when the price curve does not move parallel with the per capita currency curve, after making proper allowance for any change in efficiency of production. Of course where efficiency rises, prices tend to decrease to an equal extent; and the converse holds true.

Business Men Are Still "Jumpy"

For a long time after a harrowing experience most people are apt to be startled by the slightest reminder of it. The panic of 1920 was such an experience, and the nerves of many business man are still on edge in consequence of the financial blows then received. Witness the recent slump of stocks in Wall Street following the warnings of banks that there was danger of another inflation such as occurred in 1919 and the spring of the year following.

Leading bankers began last March to utter warnings and draw long faces. Whereupon, much to their surprise we suppose, the warnees pulled still longer faces and began to curtail activities. It was a case of whispering fire in the ear of a man just recovering from jumping out of window of a burning hotel. Even the whisper gave him a severe shock.

Now the same bankers, perceiving that their warnings were taken two seriously, are busy assuring us that there is really nothing to be alarmed about. The country never was on a sounder basis. There has been no overproduction, except perhaps of wheat. Europe is in a bad way, it is true, but it was in a worse way a year ago, and still worse two, three and four years ago. In short, the sun will rise tomorrow.

Well, we that haven't a case of the "jumps" thank our banker friends for telling us what we already knew, for it is pleasing to have our judgments confirmed. But we beg our financial prophets not to forget that all business men have not entirely recovered from the shell-shocks of 1920.

Weathering Tests of Stone

During the past month, progress has been made by the U. S. Bureau of Standards on the freezing tests of sandstone and limestone. The studies being made on samples of sandstone from the old Government quarries at Aquia Creek, Va., indicate that by careful selection a reasonably good grade of stone can be obtained for ordinary structural uses. This deposit has not been operated since the construction of the oldest Government buildings in Washington, such as the White House and the original portion of the Capitol. A new company is now preparing to work the quarry.

Economic Value of the Quantity Survey System

Editorial in The Canadian Engineer

In any discussion of ways and means of lessening waste in the construction industry, the merits of the quantity survey system should receive careful consideration. One of the most necessary reforms therein is the elimination of reduplication of estimate of quantities. According to the method now generally in vogue in this country, there are as many estimates of quantities made for a piece of work as there are contractors bidding for it. Thus, although only one out of, say, six bidders is successful, the owner must pay in large measure the costs of the estimate prepared by all of the bidders. The owner may not be aware of this fact, and it appears difficult to convince him of its truth, but there are no uncertainties with respect to the matter amongst contractors themselves. With any properly managed construction company, the necessary percentage for overhead is added to its bid to cover the cost, not only of the work which may be obtained as the result of the bid, but also the cost of making bids on a number of other jobs which have gone elsewhere. If, for simplicity, it be assumed that there are six bidders on a given piece of work, and that a contractor is successful on the average in only one out of six bids, then, assuming a series of jobs all of the same magnitude, the owner would be paying to the successful bidder the cost of making up all of the six bids which had been submitted to him. Of course all jobs are not of the same size, and the percentage of unsuccessful bids varies with different contractors and with the class of work, but an idea of the real situation can nevertheless be gained from the above illustration. If it be further assumed that the cost of preparing a bid is 0.5 per cent of the estimated cost, which is a figure on the low side, then it is seen that the owner would be paying for the entertaining of bids in the cases cited above, an amount equal to 3 per cent of the estimatd cost of the work. On complicated work where estimating costs are higher, this charge against the work might run up to as much as 10 per cent.

With the introduction of the quantity survey system, whereby all bidders would submit their tenders on the same schedule of quantities prepared

either by the engineer or by an outside quantity survey specialist, there is assurance of a higher class of work for the owner. If all bidders make up their own quantities, there are likely to be errors of interpretation as to what the engineer or architect wishes, and perhaps an assumption of inferior details where the plans are incomplete. Due to this, and to the fact that differences in conventional methods of estimating may exist as between the various bidders, there is introduced into bidding what might be called a competition on quantities. Nothing could be more undesirable than this. The owner, or his technical adviser knows, presumably, exactly what he wants and has settled upon the minimum quantity and grade of work deemed admissible for the situation. All bidders should consequently bid upon these quantities, and competition should be not on quantities or quality at all, but on the basis of efficiency of plant methods and organization.

The quantity survey system is usually considered as based on the service offered by persons or firms who specialize in this kind of work and who offer their assistance to the owner, or to his architect or engineer, for a stipulated fee. Where the owner is a layman and prepares merely rough sketches for work, or where the architect or engineer does not wish to assume any responsibility for quantity, this method of handling the work is practicable. We do not see, however, the necessity for going outside the office of the engineer or architect for the preparation of schedules of quantities. No one is better fitted to prepare such schedules than the person who prepared the plans and specifications, and in the interest of speed, accuracy and simplicity, it would appear desirable for the engineer or architect on the work to carry out the quantity survey himself and to issue a schedule of quantities to each bidder. Additional work is involved, of course, for the engineer or or architect under this procedure. If the quantities are to be accurate and to form the basis for tender, more care will need to be taken in their preparation than in the taking off of approximate quantities for the rough estimating purposes of the engineer. For such additional services, consequently, the engineer or architect should receive a fee which will be passed on to the owner. While owners have been disposed to look askance at such a proposal, it ought to be possible to show them that under such a plan there is an actual saving of money as compared with the current method of requiring every bidder to compute his own quantities and of forcing the owner to pay for all such computations in the price named by the successful bidder.

Much discussion has arisen over the matter of possible errors in the schedule of quantities. Those who urge the quantity survey system outline two possible courses of action in this connection. First, the contractor might accept the quantities of the survey as accurate, and, if successful in his bid, sign a contract based upon such quantities. If on carrying out the work, these are found to be inaccurate, adjustment can be made under the provisions covering extras and deductions. The second method proposed is to allow the successful bidder to check the quantities at his own expense prior to signing the contract. If any errors are found, the contract could be based upon the adjusted quantities. As between the two, the better method would appear to be the second. It is not advisable to admit beforehand possible claims for extras, if such can be avoided. It has been suggested that the quantity surveyor guarantee personally the quantities submitted. This has the disadvantage of encouraging the surveyor to report the quantities on the high side so as to be safe, and so as not to incur any loss under his guarantee. The assistance afforded in such a guarantee would probably be purchased at too great a cost through the temptation of the surveyor to estimate too liberally.

With an economic basis that is generally admitted as sound, the quantity survey system would appear as inevitable. It is in vogue to a very considerable extent in Great Britain and has been adopted to some extent in the United States, notably in the states of Wisconsin and Michigan. There appears to be nothing preventing its more general adoption beyond the inherent conservatism of those who pay for the construction of buildings and engineering works.

The Anonymous Architect

Editorial in New York Tribune.

In his address delivered before the Lincoln Memorial in honor of its architect, Henry Bacon, Royal Cortissoz used the phrase "unsigned buildings." To be literally accurate they are sometimes signed. But who ever turns to look at a cornerstone or read an inscription? The author's name on the title page of a book is certain to pass under the reader's eye. The architect of a great building, so far as the general public is concerned, dwells in a state of complete anonymity.

This is true not only in new America. It has been a habit of the ages, most completely and strikingly illustrated in the case of the great Gothic cathedrals. The historians have unearthed evidence as to the masters who designed Chartres, Rheims, Bourges, Amiens. But not one in a thousand of those who visit or worship at these shrines of beauty and religion could give the name of one. To an extraordinary degree these great churches of the Middle Ages were community products. Yet there were unquestionably master minds to order so much soaring beauty, and fame has utterly passed them by.

An odd trick of the world, surely. So far as length of time goes, the architect outlives all his fellow artists. He builds in the most enduring of materials. Centuries are the unit of his influence and thousands of years often mark the beginning of his glory, as the fate of the Parthenon can testify. But the immortality is for his work, not for him or his name. He can die feeling that his labor may live for ages, perhaps meet its just praise among distant generations of alien races. Hope that his name will have an equal share of immortality is slight indeed.

Does the situation point to a law of compensation existing in nature, or a cynical distrust of good architects, or a tender heart toward the bad ones? It can be contended, in any event, that the world would be a more livable place if a similar state of modesty, of fame for the work and none for the artist, were enjoined upon all human creators.

Arbitration Clause in Contracts

The following clause on arbitration has been included by the city of Wheeling, W. Va., in contracts involving about $1,000,000 worth of work:

"Article VIII. Should differences on questions other than the quality of workmanship and material arise between the city or their engineers and the contractor, on which they are unable to arrive at an amicable adjustment or understanding, they shall be, on the request of either the contractor or the city, made in writing upon the other, be referred to arbitration and if unable to agree upon a single arbitrator, then the contractor shall choose one, the city one, and the two shall choose the third, which shall constitute a judicial body empowered to investigate all features of the dispute and to render a decision in writing, delivering a copy to each party thereto, which decision shall be final and binding on both city and contractor, and the losing party of this contract shall pay the entire expense of such reference. Should the two abitrators first chosen fail after five days to agree upon a third arbitrator, then said third arbitrator shall be designated by the presiding judge of the Court of Common Pleas of Ohio County."

Portland Cement Production in June

June production of portland cement was about 12,400,000 bbls., according to figures just compiled by the United States Geological Survey. Although this represents a decline of about 500,000 bbls. from the record output of May, it neverthless establishes a new high mark for the month of June by about 10 per cent. Production for the half year ending June 30, was more than 62,300,000 bbls.—an increase of 33 per cent over the best previous record for a similar period.

June shipments from the mills amounted to 13,300,000 bbls., or slightly under those of June last year, and about 7 per cent less than in May of this year. Shipments for the first six months of this year were 62,226,000 bbls. as against 48,029,000 in the corresponding period last year.

Stocks of cement in manufacturers' hands at the end of June were 9,219,000 bbls.—a decline of approximately 9 per cent from those at the end of May.

Index Numbers of Wholesale Prices

An "index number" is really a percentage, and in the case of an "index price" shows the relative price level at different times. In the accompanying table the price level, or "index price," is 100 for the year 1913; and the indexes for other periods are those calculated by the U. S. Department of Labor.

The index for building materials is a weighted average of the principal building materials except steel.

	Farm products.	Foods.	Cloths and clothing.	Fuel and lighting.	Metal and metal products.	Building materials.	Chemicals and drugs.	House furnish'g g'ds.	Miscellaneous.	All commodities.
1913	100	100	100	100	100	100	100	100	100	100
January	98	99	99	100	107	101	100	100	106	100
October	103	102	101	102	97	98	100	101	98	101
1914	103	102	98	93	85	92	101	100	95	98
January	103	101	99	99	88	93	98	100	94	98
July	103	95	99	91	83	92	95	100	93	97
October	101	106	96	88	83	90	108	100	92	97
1915	104	105	98	88	99	94	134	100	95	101
January	104	106	94	87	82	88	108	99	99	98
April	104	105	96	82	90	90	118	99	93	99
July	104	104	96	81	106	94	130	100	94	100
October	106	102	101	94	105	98	151	100	93	102
1916	123	121	127	126	162	120	181	106	121	127
January	110	109	110	113	133	110	84	103	110	113
April	113	114	118	120	164	120	200	104	110	121
July	117	117	125	121	158	120	175	107	120	123
October	136	134	137	128	164	124	164	109	132	136
1917	190	167	175	169	231	157	202	125	148	177
January	152	149	158	171	198	138	173	118	149	153
April	184	164	164	164	230	155	186	121	153	173
July	196	169	181	176	292	168	205	129	153	188
October	207	180	185	153	207	156	231	139	142	183
1918	218	188	228	170	187	172	215	153	156	194
January	211	182	201	164	183	161	223	137	145	184
April	213	181	220	166	184	169	228	144	152	190
July	217	185	238	175	189	177	209	159	159	196
October	225	198	245	176	192	177	211	164	163	202
1919	231	207	253	181	162	201	169	184	175	206
January	224	203	220	178	175	176	181	167	166	199
April	230	205	205	177	153	169	160	167	160	199
July	241	210	262	181	160	209	167	183	177	212
October	227	205	291	189	162	229	173	194	187	211
1920	218	220	295	241	192	254	200	254	196	226
January	247	231	339	194	175	274	189	239	194	233
April	243	238	336	231	203	300	210	242	206	245
July	233	238	300	259	202	269	212	275	203	241
October	187	201	245	280	191	240	198	271	188	211
1921	124	144	180	199	129	165	136	195	128	147
January	143	162	196	247	153	192	153	217	154	170
February	133	151	188	225	147	180	149	217	147	160
March	127	151	183	212	140	173	143	216	139	155
April	117	144	176	205	138	167	135	216	130	148
May	118	139	173	200	138	165	134	209	126	145
June	114	137	172	191	133	163	133	196	125	142
July	119	141	172	186	124	160	129	180	123	141
August	123	146	171	184	117	156	129	179	119	142
September	124	142	178	181	116	156	131	179	118	141
October	124	140	180	189	116	159	131	180	118	142
November	121	139	180	197	114	163	129	178	119	141
December	120	136	180	199	113	158	127	178	121	140
1922	133	139	180	220	122	169	124	176	117	149
January	122	131	176	195	112	157	124	178	117	138
February	131	135	174	191	110	156	123	177	117	141
March	130	137	172	191	109	155	125	175	117	142
April	129	137	171	194	113	156	124	175	116	143
May	132	138	175	216	119	160	122	176	116	148
June	131	140	179	225	120	167	122	176	114	150
July	135	142	180	254	121	170	121	173	114	155
August	131	138	181	271	126	172	122	173	115	155
September	133	138	183	244	134	180	124	173	116	153
October	138	140	188	226	135	183	124	176	120	154
November	143	143	192	218	133	185	127	179	122	156
December	145	144	194	216	131	185	130	182	122	156
1923—										
January	143	141	196	218	133	188	131	184	124	156
February	142	141	199	212	139	192	132	184	126	157
March	143	143	201	206	149	198	135	185	127	159
April	141	144	205	200	154	204	136	187	126	159
June	138	142	198	186	148	194	131	187	123	153
May	139	144	201	190	152	202	134	187	125	156

Retail Prices of Building Materials

Average prices paid June 1, 1923, by contractors for building materials delivered on the job. These prices are secured through the Bureau of the Census and published monthly by the Division of Building and Housing of the Bureau of Standards, United States Department of Commerce.

The report as published by the Division of Building and Housing gives prices at 43 cities, 28 of which are included in the table herewith. Boston, New York, Philadelphia, Chicago and San Francisco are among the places not listed in the Bureau's report for June 1.

Item No.	Commodity. Size and condition.	Unit.	Haverhill, Mass.	New London, Conn.	Poughkeepsie, N. Y.	Rochester, N. Y.	Buffalo, N. Y.	Baltimore, Md.	Richmond, Va.	Columbia, S. C.	Savannah, Ga.	New Orleans, La.
1.	Common brick	1,000	$26.50	$32.00	$20.00	$17.75	$23.00	$20.00	$19.00	$12.00	$17.50	$16.50
2.	Portland cement, excl. of containers	Bbl.	3.50	3.68	2.80	3.35	3.03	3.50	3.15	4.00	3.85	3.00
3a.	Yellow pine, No. 1, dimension 2x4—16′, S1S1E	M	65.00	60.00	.....	48.00	49.00	40.00	32.00	.....	30.00	41.00
3b.	Douglas fir, No. 1, dimension 2x4—16′, S1S1E	M	.....	.....	50.00	56.00	55.00	.....	.....	.....	.....	.....
3c.	N. Carolina pine, No. 1, dimension 2x4—16′, S1S1E	M	.....	.....	.....	48.00	.....	.....	.....	25.00	30.00	.....
4.	Common boards, No. 1, 1x6	M	48.00	45.00	47.00	45.00	45.00	.....	45.00	30.00	50.00	40.00
5a.	Y. P. flooring edge, grain "C," 1x4—10′—16′	M	102.00	135.00	130.00	130.00	72.00	140.00	125.00	100.00	55.00	85.00
5b.	Douglas fir V. G., No. 2, 1x4—10′—16′	M	.....	.....	.....	.....	105.00	.....	.....	.....	.....	.....
6a.	Red cedar shingles, extra clear, 16″, 5 to 2	100 sq. ft.	6.50	6.00	.....	6.25	6.00	11.20	.....	.....	.....	5.80
6b.	Cypress shingles, extra clear, 16″, 5 to 2	100 sq. ft.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6c.	Composition shingles, crushed slate surfaced	100 sq. ft.	7.50	7.00	6.25	.....	.....	6.00	7.50	7.00	6.50	.....
7.	Gypsum plaster board, ⅜″	1,000 sq. ft.	40.00	50.00	45.00	30.00	45.00	32.50	35.00	35.00	40.00	45.00
8.	Lime, HYD, com	Ton	24.00	26.00	22.00	21.00	16.00	17.25	22.80	20.00	22.50	.....
9.	Building sand	Cu. Yd.	2.60	1.50	2.50	2.25	1.28	2.50	2.25	1.40	2.25	2.00
10.	Crushed stone, ¾″	Ton	3.50	2.50	2.60	2.25	1.30	4.00	.....	3.00	5.25	.....
11.	Wire nails	Keg	5.50	.....	4.25	4.25	4.25	4.00	4.50	4.25	4.05	3.90
12.	Window glass, single A, 10″x12″	50 sq. ft.	.....	.....	.....	4.20	4.20	5.10	5.80	6.25	.....	4.20
13.	Hollow tile, 8″x12″x12″	Each	.30	.....	.22	.21	.22	.24	.28	.20	.....	.22
14.	Cast iron soil pipe, 4″ E. H., 13 lbs. per ft	Ton	.....	.....	.....	100.10	90.55	82.60	.....	.....	.....	.....
15.	Steel pipe, 1″ galv	100 ft.	.....	.....	.....	10.52	10.00	10.10	.....	11.80	9.46	.....
16.	Reinforcement bars, ¾″ square	100 lbs.	4.75	.....	4.50	3.60	.....	3.50	3.75	4.50	5.00	3.75
17.	Structural steel, fab. 6″ I beams	100 lbs.	5.75	.....	5.50	4.50	.....	3.50	4.50	5.00	5.00	5.50
18.	White lead, dry	100 lbs.	.....	.....	.....	13.05	14.50	13.05	.....	15.25	14.00	12.75
19.	Zinc oxide, Am. process lead free	100 lbs.	.....	.....	.....	.....	.....	.....	.....	20.00	20.00	.....
20.	Gypsum plaster, neat	Ton	27.00	26.00	.....	18.00	17.00	21.50	.....	20.00	22.50	21.00
21.	Linseed oil, raw, in bbls	Gal.	1.30	.....	.....	1.29	1.31	1.40	1.25	1.45	1.35	1.27
22.	Roofing slate, No. 1 ribbon	100 sq. ft.	.....	.....	.....	.....	.....	.....	13.50	.....	.....	.....
23.	Tar paper, roofing, 2-ply, 75 lbs. per roll of	100 sq. ft.	.....	.....	3.50	1.80	2.00	3.75	.....	.....	1.90	2.00
24.	Rosin sized sheathing, 3-ply, 30 lbs. per roll of	500 sq. ft.	1.60	1.60	1.75	1.50	1.50	1.45	1.50	.....	1.00	1.85

Item No.	Shreveport, La.	Pittsburgh, Pa.	Cleveland, Ohio	Dayton, Ohio	Detroit, Mich.	Bay City, Mich.	Waterloo, Iowa	Council Bluffs, Iowa	Kansas City, Mo.	St. Louis, Mo.	Grand Forks, N. D.	Sioux Falls, S. D.	San Antonio, Tex.	Tucson, Ariz.	Sacramento, Calif.	Los Angeles, Calif.	Seattle, Wash.	Portland Ore.
1.	$15.00	$18.00	$16.00	$18.00	$17.50	$15.00	$14.80	$16.50	$16.50	$18.50	$15.00	$18.00	$17.00	$15.00	$17.00	$15.00	$20.00	$20.00
2.	3.20	3.10	3.48	3.60	3.72	3.25	3.00	3.10	2.45	2.85	4.00	3.86	3.60	4.40	3.55	3.26	3.10	3.65
3a.	49.00	55.00	60.00	57.50	50.00	50.00	54.00	50.00	50.00	41.50	.....	.....	57.00	.....	.....	.....	.....	.....
3b.	.....	.....	.....	57.50	.....	.....	52.00	48.00	50.00	47.00	56.00	51.50	.....	65.00	46.50	49.50	25.00	24.00
3c.	.....	.....	.....	52.50	50.00	.....	56.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4.	54.00	54.00	52.00	70.00	50.00	48.00	46.00	48.00	60.00	51.00	53.00	48.50	66.00	62.50	48.00	48.00	25.00	24.00
5a.	100.00	83.00	102.00	.....	.....	80.00	95.00	110.00	65.00	87.00	.....	.....	120.00	.....	.....	.....	.....	.....
5b.	.....	.....	.....	90.00	.....	.....	95.00	100.00	.....	.....	100.00	87.00	.....	100.00	83.50	87.75	60.00	57.00
6a.	7.00	7.50	6.00	6.20	7.25	6.00	6.50	6.80	6.50	6.25	6.00	5.40	6.80	.....	5.65	5.88	3.65	5.00
6b.	6.50	.....	.....	6.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.00	.....	.....	.....	.....
6c.	6.25	6.50	6.25	6.50	.....	6.50	7.50	8.25	6.00	6.30	.....	7.50	.....	.....	.....	.....	.....	.....
7.	40.00	37.50	32.00	50.00	30.00	43.00	36.00	.....	35.00	42.50	60.00	32.00	.....	.....	41.50	45.00	34.00	50.00
8.	25.00	23.00	18.00	15.20	20.00	16.50	20.00	28.00	25.60	20.00	.....	24.00	18.00	23.00	.....	25.00	22.00	26.00
9.	2.00	2.50	2.50	2.00	2.75	2.50	1.75	3.50	2.50	2.65	3.00	.....	2.25	1.15	1.50	1.60	1.75	2.25
10.	5.40	6.00	3.50	2.00	2.35	3.50	3.50	5.00	2.25	.....	.....	3.00	2.00	3.00	2.75	2.15	2.00	.....
11.	4.60	3.50	3.50	3.90	4.25	3.40	4.50	5.75	4.60	.....	5.50	5.00	6.20	6.25	.....	4.50	4.35	4.50
12.	4.25	5.95	.....	4.50	4.80	5.40	5.25	.....	4.50	4.50	.....	.....	4.50	.....	.....	5.10	4.42	.....
13.	.22	.21	.....	.21	.19	.21	.17	.14	.22	.....	.....	.....	.25	.18	.....	.19	.25	.....
14.	97.00	68.00	.....	.....	61.23	84.50	82.00	.....	.....	.....	88.00	.....	120.00	.....	.....	.....	115.50	112.02
15.	11.95	9.86	.....	10.57	10.71	9.75	12.00	.....	.....	.....	13.80	.....	11.12	13.25	.....	12.30	12.50	16.50
16.	4.50	4.00	.....	6.00	3.45	3.75	4.00	3.40	.....	3.48	5.70	.....	4.15	4.50	.....	3.55	3.00	4.00
17.	5.00	3.75	.....	3.25	8.00	4.65	4.95	4.50	.....	5.10	5.70	.....	4.50	.....	.....	8.00	5.00	9.00
18.	15.00	14.50	14.50	14.50	14.50	13.75	14.50	15.50	12.35	14.50	.....	.....	15.75	15.75	.....	14.00	11.75	13.50
19.	.....	17.00	.....	15.00	.....	18.70	19.00	.....	.....	.....	.....	.....	16.00	.....	.....	13.00	.....	.....
20.	24.00	22.00	.....	18.00	17.00	18.00	18.00	18.00	.....	18.00	27.00	.....	24.00	21.00	.....	.....	21.00	24.00
21.	1.30	1.17	1.27	1.20	1.45	1.15	1.30	1.55	.92	1.31	2.00	.....	1.50	1.42	.....	1.35	1.43	1.50
22.	12.00	13.50	.....	15.00	.....	17.50	18.00	.....	.....	.....	.....	.....	18.00	.....	.....	.....	.....	30.00
23.	2.25	1.95	2.50	1.80	2.10	2.80	3.25	3.60	.....	.....	3.00	2.80	3.50	2.90	.....	2.25	2.50	.....
24.	1.25	1.35	.90	2.00	1.20	1.10	1.50	1.50	1.20	1.23	2.00	1.50	2.25	1.75	.....	1.50	1.20	1.80

Pittsburgh Steel and Iron Prices

The following data on prices and freight rates are taken from The Iron Age of July 12:

Plates, sheared, tank quality, base, per lb	2.50c
Beams, channels, etc., base, per lb	2.50c
Soft steel bars, base, per lb	2.40c
Reinforcing steel bars, base, per lb	2.40c
Track spikes, 9/16 in. and larger, base, per 100 lbs	$3.15
Track spikes, ½ in. and smaller base, per 100 lbs	3.50-3.75
Spikes, boat and barge, base, per 100 lbs	3.50-3.75
Track bolts, ¾-in. and larger, base, per 100 lbs	4.00-4.25
Tie plates, per 100 lbs	2.55-2.60
Angle bars, base, per 100 lbs	2.75
Butt welded steel pipe, ¾-in.—Percentage discount—Black 60; galv.	48½
Butt welded steel pipe, 1 to 3 in.—Percentage discount—Black 62; galv.	50½
Lap welded steel pipe, 2½ to 6 in.—Percentage discount—Black 59; galv.	47½
Pig iron, No. 2X, Philadelphia, per gross ton	$28.26
O.h. rails, heavy, at mill, per gross ton	43.00

Freight Rates

All rail freight rates from Pittsburgh on domestic shipments of finished iron and steel products, in carload lots, to points named, per 100 lbs., are as follows:

Philadelphia	$0.32	St. Louis	0.43
Baltimore	0.31	Kansas City (pipe)	$0.705
New York	0.34	St. Paul	0.60
Boston	0.365	Omaha	0.735
Buffalo	0.265	Omaha (pipe)	0.705
Cleveland	0.215	Denver	1.27
Cleveland, Youngstown, comb.	0.19	Denver (pipe)	1.215
Detroit	0.29	Pacific Coast	1.50
Cincinnati	0.29	Pac. Coast, ship plates	1.20
Indianapolis	0.31	Birmingham	0.69
Chicago	0.34	Memphis	0.385
		Jacksonville, rail and water	0.415

Respective Services of Constructor and Designer

The performance of construction under the day labor plan by public officials who underestimate the value of a constructor's managerial function, combined with the tendency of constructors and designers to confuse their own respective functions, has indicated the need for a clean-cut statement of what service each of these agencies should rightfully perform for their clients. A clear definition of their respective services appears essential, and it is to develop such a definition that the accompanying statement of functions had been formulated by the Committee on Methods of the Associated General Contractors and printed in the June 16 News Letter of the Association:

Declaration for Cooperation in Building

The Constructor	The Designer
Will insure completion of project	1. Will design complete throughout, including structural design
Will make quantity survey of plans	2. Will permit ample time for bidding
Will submit bids at stated period	3. Will open bids in public
Will bid freely in competition	4. Will specify materials freely competitive
Will base bid on his previous unit costs	5. Will award work at the bid price
Will submit evidence of responsibility	6. Will permit only responsible contractors to bid
Will guarantee cost of the work shown on plans and specifications	7. Will give complete information as to dimensions, quantity, quality and design
Will warrant time of delivery of structure	8. Will furnish detail plans without delay
Will develop adequate financial credit	9. Will approve estimates promptly
Will supply adequate construction equipment	10. Will allow equipment rental on monthly estimates
Will furnish ample tools	11. Will furnish ample details
Will furnish bond for faithful performance to owner	12. Will fearlessly demand justice from the owner
Will sign Joint Committee form of contract	13. Will submit Joint Committee form of contract
Will perform portions of work with his own construction force	14. Will supervise work with his own force
Will supply experienced superintendence	15. Will supply practical supervisors
Will protect owner against liens	16. Will examine specified patented products for prescribed royalties
Will insure owner against all accidents	17. Will allow insurance premiums as part of actual costs
Will be fair to subcontractors	18. Will let General Contractor award all subcontracts
Will be always fair to labor	19. Will make specifications clear for all divisions of work
Will keep quality standards high	20. Will arrange for inspection of materials at source
Will guard public interest in labor rates and conditions of employment	21. Will not urge continuance of work in case of strikes or lock-outs
Will cooperate through local chapter of contractors	22. Will assist the local chapter of Architects
Will display skill in construction methods	23. Will be resourceful in design of structures
Will through integrity inspire business confidence	24. Will reward square dealing
Will support rulings of National Board for Jurisdictional Awards	25. Will specify in accordance with decisions of the National Board for Jurisdictional Awards
Will be loyal to designers	26. Will respect loyalty of constructors
Will help train apprentices	27. Will encourage young workmen
Will assume responsibility for errors in construction	28. Will assume responsibility for errors in design
Will develop sound commercial practices	28. Will permit arbitration as to dollars
Will charge legitimate construction fees	30. Will charge the A. I. A. designing fees
Will shake hands with Designer upon receipt of final estimate	31. Will pat Constructor on the back upon completion of the job

then

the CONSTRUCTOR would not have time nor the trained professional technique to adequately design work.

the DESIGNER would not have time nor the experienced business organization to efficiently undertake construction work.

and

The Owner

would get the best possible construction service

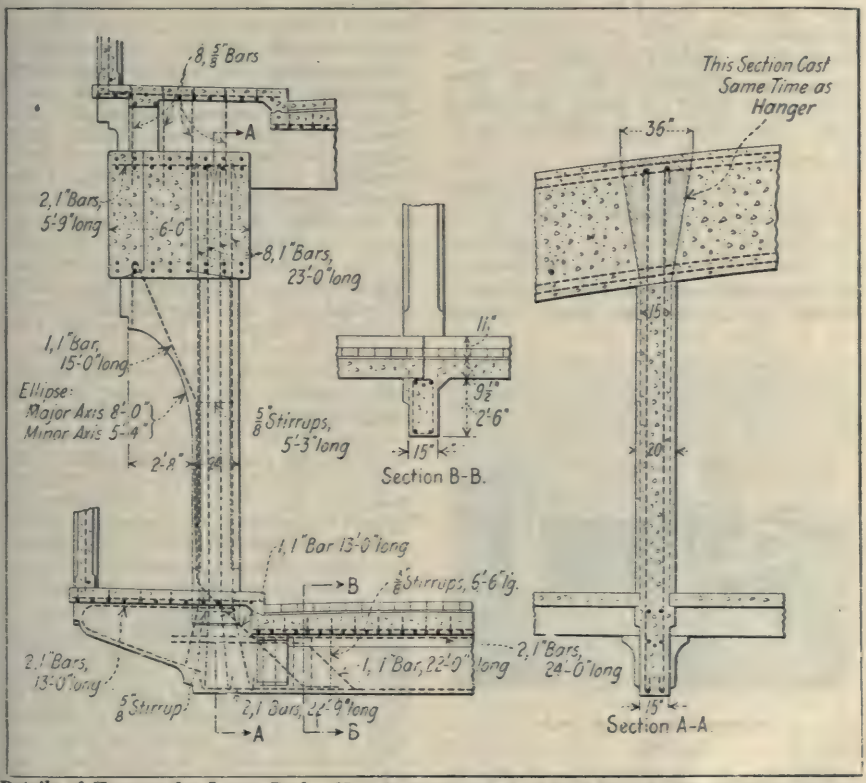
from Both.

"Modern Construction embodies fine architectural symmetry and aesthetic design developed through past ages and now reared upon tested scientific engineering principles of strength and proportion of materials gathered throughout the world, stored for prompt delivery, fabricated in special shops, and speedily and economically erected with skillful methods by experienced artisans into a beautiful, practical structure for a useful purpose."

Unusual Design of Concrete Bridge

In the design of the concrete highway bridge at Watertown, N. Y., a clever use was made of the adaptability of concrete by making the bridge of double-deck construction. The upper deck carried the heavy traffic of Court and Coffeen Sts. over the Black River and also across the railroad which parallels the river. The lower deck carries lighter traffic of River and Newell Sts., which are parallel to the river and north of the railroad. We are indebted to Contractor's Atlas for the following detail:

The bridge is carried over the river on four reinforced arch ribs, the up-

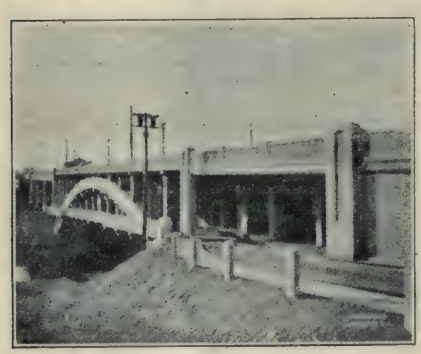


Details of Hangers for Lower Deck. Note in Section A-A Method Used for Pouring Hangers to Prevent Cracks.

Double Deck Concrete Highway Bridge Over Black River at Watertown, N. Y.

per deck being supported by open spandrel construction and the lower deck being hung from the arch rib. The arch ribs are 6 ft. wide and 5 ft. deep, so spaced as to give two 12-ft. roadways and two 4-ft. sidewalks on the lower deck. The river span is 195 ft. and the height of the arch rib above the springing line 38 ft. The lower deck is 22 ft. below the upper deck. The span across the railroad is 86 feet.

To avoid cracks in the hangers supporting the lower roadway, due to the difference in the moduli of elasticity of the steel reinforcing and the concrete an ingenious method was employed. When the arch ribs were poured



Approach to Lower Deck.

wedge-shaped openings were left at the points where the steel rods were hung to support the lower deck. After the lower deck was placed, the supports were removed, permitting these rods to be stressed with the entire dead load of the lower deck, thus taking the full deformation due to this dead load. Forms were then built around these hanger rods and the concrete poured, embedding them. Thus the only additional elongation of the steel which may be expected will come from live loads which will not be sufficient to cause any appreciable cracking in the concrete.

The Concrete Steel Engineering Co. of New York City were the designing and supervising engineers. The bridge was built by the Peckham Construction Co. of Buffalo, and Atlas portland cement was used in its construction.

Methods of Measuring the Properties of Electrical Insulating Materials

Scientific Paper No. 471 of the Bureau of Standards, which can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 15 cts. a copy, describes methods of measuring the properties of electrical insulating materials. This paper gives a series of electrical, thermal, chemical, and mechanical test methods which have been found useful in the study of solid electrical insulating materials. The several tests described are those used in obtaining the data previously reported in Technologic Paper No. 216 of the Bureau of Standards entitled "Properties of Electrical Insulating Materials of the Laminated Phenol-Methylene Type." The several test methods described are radio-frequency phase difference or power loss, dielectric constant and flashover voltage, direct-current surface resistivity and volume resistivity, tensile strength, modulus of elasticity (tensile), proportional limit, modulus of rupture, modulus of elasticity (transverse), Brinell hardness, soleroscope hardness, resistance to impact, permanent distortion, density, moisture absorption, machining qualities, thermal expansivity, and the effects of heat, acid, and alkali. The methods and apparatus are described in some detail; first, so that the data in Technologic Paper No. 216 will be definite and be capable of being correctly compared with other data; second, so that any of the tests may be reproduced by others.

Tests of Parts of the New Delaware River Bridge

As mentioned some time ago, the U. S. Bureau of Standards is conducting a co-operative investigation with the Joint Commission of Pennsylvania and New Jersey on the strength of certain members of the new bridge across the Delaware River between Philadelphia and Camden. The general problem in hand is the compressive strength of web plates; and it has been found, as might be expected, that the strengths are a function of the properties of the material. A special study is now under way on the relation between the properties and certain metallurgical phenomena which have been developed during the investigation.

Analysis of "Two-Way" Flat Slabs

Method Following Closely Joint Committee Report and Chicago Ordinance Described in The Architectural Forum

By E. F. ROCKWOOD

Floor slabs of reinforced concrete supported upon columns without beams or girders and extending two or more bays in each direction are commonly known as flat slabs. The columns may be, and usually are, provided with enlarged heads. In addition, the slab may be thickened on the under side in the vicinity of the columns, forming what is known as a "drop" or a "depression."

The sketches given here show the cracks that developed in four test

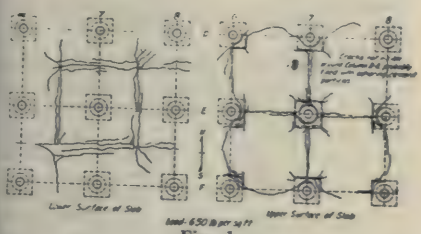


Fig. 1.

panels of a flat slab floor in a building built in Chicago in 1921. These cracks indicate the regions of high tensile stress where reinforcing steel is needed. Such reinforcing steel can be at right angles to the cracks, taking the stresses directly, or by crossing the cracks at an angle can take components of these stresses.

Systems of Arranging Reinforcement.—The writer knows of three common systems of arranging such reinforcements,—the two-way system, the four-way system, and the S. M. I. system. The latter requires less steel than either of the others, but the steel in it is more complicated to design, bend and place, and if the system is used a royalty must be paid. The other two systems require approximately equal amounts of steel, but the two-way system is simpler to place and has only two layers of steel over the column heads, which allows the concrete to be more readily placed. The writer therefore favors the two-way system. In this system all the rods run parallel with the column lines in two directions, and where they do not cross a crack line at right angles the stress causing that crack is carried by components of two rods at right angles to each other.

Many theories have been advanced for the design of flat slabs, and engineers do not agree upon any one of these, but tests on floors that have been built furnish sufficient data for arbitrary methods of design, and one of the best of them is described by these specifications and is illustrated in Figs. 2 and 3.

Capital.—Columns shall be provided with enlarged capitals, and the diameter (c) of this capital shall be the base diameter of the largest right circular cone which lies entirely within the column (including the capital) whose vertex is 90 deg. and whose base is 2½ in. below the bottom of the slab or the bottom of the dropped panel. The diameter of the capital shall not be less than 1/5 the distance center to center of the columns, and shall be such that the unit stresses specified elsewhere are not exceeded.

Brackets.—Brackets or haunches shall be provided on exterior columns when necessary to transmit the shear and bending from the slab to the column.

Interior Columns.—The smallest dimension of interior concrete columns supporting flat slabs shall be not less than 1/15 the span, center to center, of columns in the longer direction.

Dropped Panel.—A thickening of the slab on the under side in the vicin-

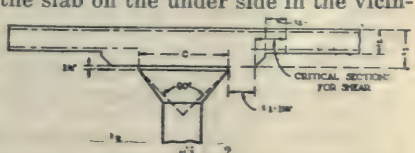


Fig. 2.

ity of the columns is termed a dropped panel. Its width in any direction shall not be less than 1/3 the panel's length in that direction, and its thickening shall not be greater than 1.5 times the slab thickness.

Thickness of Flat Slabs and Dropped Panels.—The minimum thickness of floor slabs shall not be less than 1/32 and of roof slabs 1/40 of the distance center to center of columns in the longer direction. The thickness shall be such as to withstand

the shear around the column capital or around the dropped panel.

Shear.—Shearing Stress. The shearing unit shearing stress shall not exceed the value of "v" in the formula,

$$v=0.02f'_c\ (1+r)$$

nor in any case shall it exceed 0.03 f'_c (f'_c=ultimate compressive strength of the concrete at 28 days).

The unit shearing stress shall be computed on:

(a) A vertical section which has a depth, in inches, of ⅞ (t_1—1½), and which lies at a distance, in inches, of t_1—1½ from the edge of the column capital; and

(b) A vertical section which has a depth, in inches, of ⅞ (t_2—1½), and which lies at a distance, in inches, of t_2—1½ from the edge of the dropped panel.

In no case shall "r" be less than 0.25. Where the shearing stress on

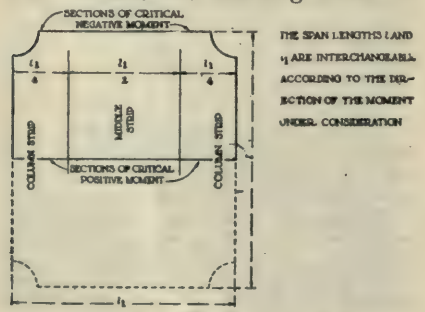


Fig. 3.

section (a) is being considered, "r" shall be taken as the proportional amount of reinforcement crossing the column capital; where the shearing stress at section (b) is being considered, "r" shall be taken as the proportional amount of reinforcement crossing entirely over the dropped panel. (For typical flat slab and designation of principal design sections, see Figs. 2 and 3.)

Moments.—In an interior panel the bending shall be taken thus:

(a) Negative moment in middle strip: Extending in a rectangular direction from a point on the edge of panel $\frac{l_1}{4}$ from column center a distance of $\frac{l_1}{2}$ toward the center of adjacent column on the same panel edge.

(b) The maximum negative moment and the maximum positive moments in the middle strip and the sum of the maximum positive moments in the two column strips may each be greater or less than the values given in the table herewith by not more than 0.01Mo.

Moments for Slabs with Two-Way Reinforcement

Strip	Flat Slabs without Dropped Panels Negative	Flat Slabs without Dropped Panels Positive	Flat Slabs with Dropped Panels Negative	Flat Slabs with Dropped Panels Positive
Column strip	0.25 Mo	0.11 Mo	0.25 Mo	0.10 Mo
Two-column strips	0.46 Mo	0.22 Mo	0.50 Mo	0.20 Mo
Middle strip	0.16 Mo	0.16 Mo	0.15 Mo	0.15 Mo

In flat slabs in which the ratio of reinforcement for negative moment in the column strip is not greater than 0.01, the numerical sum of the positive and negative moments in the direction of either side of the panel shall be taken as not less than:

$$Mo=0.09\ Wl\ (1-2/3\frac{c}{l})^2$$

Where Mo=sum of positive and negative bending moments in either rectangular direction at the principal design sections of a panel of a flat slab.

c =base diameter of the largest right circular cone which lies entirely within the column (including the capital) whose vertex angle is 90 deg. and whose base is 1½ in. below the bottom of the slab or the bottom of the dropped panel. (See Fig. 2.)

l =span length of flat slab, center to center of columns in the rectangular direction, in which moments are considered; and

W =total dead and live load uniformly distributed over a single panel area.

Wall and Other Irregular Panels.—In wall panels and other panels in which the slab is discontinuous at the edge of panel, the maximum negative moment one panel length away from discontinuous edge and maximum positive moment between shall be taken thus:

(a) Column strip perpendicular to the wall or discontinuous edge. 15 per cent greater than that given in table.

(b) Middle strip perpendicular to wall or discontinuous edge. 30 per cent greater than that given in table.

In these strips the bars used for positive moments perpendicular to the discontinuous edge shall extend to the exterior edge of the panel at which the slab is discontinuous.

Panels with Wall Beams.—In panels having a marginal beam on one edge, or on each of two adjacent edges, the beam shall be designed to carry the load superimposed directly upon it. If the beam has a depth greater than the thickness of the dropped panel into which it frames, the beam shall be designed to carry, in addition to the load superimposed upon it, at least one-quarter of the distributed load for which the adjacent panel or panels are designed, and each column strip adjacent to the parallel with the beam shall be designed to resist a moment at least one-half as great as that specified in the table for a column strip. If the beam used has a depth less than the thickness of the dropped panel into which it frames, each column strip adjacent to and parallel with the beam shall be designed to resist the moments specified in the table for a column strip. Where there are beams on two opposite edges of the panel, the slab and the beam shall be designed as though all the load were carried to the beam.

Flat Slabs on Bearing Walls.—Where there is a beam or a bearing wall on the centre line of columns in the interior portion of a continuous flat slab, the negative moment at the beam or wall line in the middle strip perpendicular to the beam or wall shall be taken as 30 per cent greater than the moment specified in the table for a middle strip. The column strip adjacent to and lying on either side of the beam or wall shall be designed to resist a moment at least one-half of that specified for a column strip.

Point of Inflection.—The point of inflection in any line parallel to a panel edge in interior panels of symmetrical slabs without dropped panels shall be assumed to be at distance from the center of the span equal to 3/10 of the distance between the two sections of critical negative moment at opposite ends of the line; for slabs having dropped panels the coefficient shall be ¼.

Arrangement of Reinforcement.—The design shall include adequate provision for securing the reinforcement in place so as to take not only the critical moments, but also the moments at intermediate sections. At least two-thirds of all bars in each direction shall be of such length and shall be so placed as to provide reinforcement at two sections of critical negative moment and at the intermediate section of critical positive moment. Continuous bars shall not all be bent up at the same point of their length, but the zone in which this bending occurs shall extend on each side of the assumed point of inflection, and shall cover a width of at least 1/15 of the panel length. Mere sagging of the bars shall not be permitted. In four-way reinforcement the position of the bars in both diagonal and rectangular directions may be considered in determining the width of zone of bending.

In general the negative bending moment for a panel width along a section at and parallel to the wall columns shall be taken as 5/16 Mo. The bending in the exterior columns shall be taken as 5/16 Mo. $\frac{Wh}{4}$ where "h" is the thickness of exterior column.

This method follows very closely that used in the latest report of the "Joint Committee" and the Chicago Ordinance, as it is practically a combination of both.

Stucco Investigation

For several years past, the U. S. Bureau of Standards has been studying stuccos, and many of its findings have been embodied in a "Recommended Practice for Portland Cement Stucco" which was formally adopted recently by the American Concrete Institute as one of its standards. The practice covers the application of stucco to all bases, and although a masonry base is probably capable of giving the most dependable results, it is recognized that there has been and probably will be for many years to come a larger use of stucco on frame houses than on masonry structures.

The application of stucco to frame houses involves greater uncertainties in results than on masonry bases, and in order to solve some of these problems, the Bureau proposes to carry out, in co-operation with some of the interested trade associations, a study involving about 30 test panels on the stucco test building. Considerable interest has been shown in this work, and a conference will probably be held in the near future. If the full co-operation of the interests involved is secured, it is planned to start work early in the Fall.

Live Floor Load Requirements in School Buildings

Some interesting information indicating the wide variation in live floor loads for school buildings is given by Norman M. Stineman in the American Architect. The accompanying table, from his article, is based on building codes selected at random:

Building Code	Live Loads Class Rooms	Lbs. per sq. ft. Corridors and Assembly Halls
Milwaukee	40	60
Flint, Mich.	40	70
Baltimore	50	75
Omaha	50	75
Seattle	50-75	75-100
Detroit	50-60	80
Portland (Ore.)	60	75
Ohio State Code	60	80
Wisconsin State Code	60	80
Boston	60	125
Cincinnati	60	80-100
New Orleans	60	125
Memphis	70	100
Bayonne, N. J.	75	90
Chattanooga, Tenn.	75	100
Columbia, S. C.	75	90
Everett, Wash.	75	125
Minneapolis	75	100
Newton, Mass.	75	125
New York City	75	100
St. Louis	75	100
Galveston, Tex.	100	125
Great Falls, Mont.	100	125

Commenting upon the table, Mr. Stineman says: In Detroit the specified floor load is 50 lbs. per sq. ft. in class rooms with fixed seats, and 60 lbs. with movable seats. In Cincinnati the required floor load is 80 lbs. in corridors and 100 lbs. in assembly rooms. In Seattle the specified load is 50 lbs. in class rooms seating less than 100 pupils, 75 lbs. in class rooms seating more than 100 and in assembly rooms with fixed seats, and 100 lbs. in assembly rooms with movable seats. In Boston and New Orleans the load of 125 lbs. per sq. ft. applies to assembly halls only.

A glance at the above table will readily explain why it is that school buildings in some cities seem to cost too much money. The table indicates also that the requirements of state building codes and those of large cities are not so severe as those of medium sized cities. The reason for the difference is that states and large cities have better facilities for revising their building codes and that on the average they do revise them more frequently than the smaller cities do; consequently the code of the large city is kept more nearly abreast of modern ideas.

Cities that require school building class rooms to be designed for a live floor load of 100 lbs. per sq. ft., and the corridors, assembly halls, and laboratories for 125 lbs., are practically demanding warehouse loading for school rooms. They are wasting money in their treasuries which is contributed by their own taxpayers.

Actual Live Floor Load in Buildings.—A good way to obtain an estimate of the actual live floor load in school buildings, or any other buildings for that matter, consists in actually weighing or computing the weight of the school furniture, adding the estimated combined weight of the people occupying the school room, allowing additional weight for books and similar objects, then dividing the total weight by the area of the school room. A fairly accurate estimate can be made without the necessity of conducting an actual test. A standard class room is 23 by 32 ft. in plan and has a capacity of 45 pupils. The floor area is 736 sq. ft. The weight ordinarily imposed on the floor may therefore be estimated by assuming the average weight of the pupils and the teacher at 100 lbs., making a total of 4,600 lbs. The weight of 45 desks at 40 lbs. each is 1,800 lbs. The teacher's desk, including the books and papers in it, will weigh hardly more than 400 lbs. The books in the possession of each pupil may average as much as 10 lbs. per pupil, making a total of 450 lbs. Allowing 250 lbs. for a few small charts or other minor objects, we obtain a total live floor load of 7,500 lbs., or only slightly more than 10 lbs. per sq. ft. of floor area.

Ten lbs. per sq. ft. may therefore be considered the average live floor load in a class room. The maximum floor load may be estimated on the assumption that the room would occasionally be filled with grown people, two persons occupying each seat and 30 people standing around the walls, making a total occupancy of 120 persons having an average weight of 150 lbs., or a total weight of 18,000 lbs. The other items would remain as in the first estimate, so that the total weight would be 20,900 lbs., or an average of 28 lbs. per sq. ft. This figure can surely be accepted as the extreme load likely to be imposed on a class room floor.

What, then, is the excuse for specifying loads such as 100 lbs. per sq. ft., as some cities do, or even 75 lbs., specified in many large cities? The 60-lb. load specified by the state codes of Ohio and Wisconsin, although in line with modern practice, seems very conservative in view of the facts.

Webb Plate Compression Tests

Tests were made by the U. S. Bureau of Standards to determine the value of Webb plates in compression, with special reference to the design of the main towers of the Delaware River bridge now being constructed between Philadelphia and Camden, N. J. The following note on these tests were given by Ralph Modjeski, Consulting Engineer, for the bridge in a paper presented last April before the Western Society of Engineers.

The Main Towers are being made of silicon steel plates and angles with a specified minimum wield point of 45,000 lb. per square inch. The construction is box shape or cellular, the webs varying in thickness from ¾ in. to 3 in. with a general thickness of 1½ in. made up of two ¾ in. plates stitch riveted together. The maximum unsupported width between the toes of the angles is 23 in. for the ¾ in. webs and 46 in. for the 1½ in. webs, or in each case about 31 times the thickness. A unit stress of 24,000 lb. per square inch was used in the design of the tower for compression due to combined direct stress and bending. To establish the propriety of using this unit stress with the grade of steel specified and with webs of the width and thickness planned, was therefore the specific object of the tests, the more general objects being to find the comparative strength and behavior of thick and thin webs and of webs of single or double plates.

The Test Pieces.—For these tests fourteen silicon steel plate girders were made, 10 ft. long, 35 in. deep, with four 6 in. x 4 in. x ¾ in. flange angles per girder, and with seven different thicknesses or types of webs, there being two girders of each type. The different types of webs are shown in the following table, together with the ratios of unsupported width to thickness. The unsupported width between the toes of the flangle angles was 23 in. so that the girders with the ¾ in. webs were practically segments taken from the towers of the bridge.

Webs	Width Radio
One ⅜ in. plate	61
One ½ in. plate	46
One ⅝ in. plate	37
One ¾ in. plate	31
One 1 in. plate	23
Two ½ in. plates	23
Two ¾ in. plates	15

Plates thinner than any contemplated for use in the towers were included in the tests in order to be sure of finding the comparative behavior of thick and thin plates.

Method of Testing.—The girders were tested lengthwise in compression up to and well beyond the maximum load they would carry. The flanges were stayed against lateral deflection by means of stiffening girders which were fastened to them with lubricated clamps so that the stiffening girders would carry very little if any of the load, Ames dial compressometers were rigged to each flange angle of the test girders for the purpose of measuring the shortening, and similar compressometers were placed on the stiffening girders to detect any stress in them. Various other gauges were placed on the girders to measure local strains and lateral deflections, and a device was rigged up to measure the contour of the web surface before and during the test.

Maximum Strength.—The maximum strength developed by the girders varied between 40,000 lb. and 46,400 lb. per square inch with an average of 44,300 lb. per square inch. Of the girders with webs ¾ in. thick and over, which serve as a criterion for the towers, the maximum strength varied between 44,000 lb. and 46,400 lb. per square inch, with an average of 45,300 lb. per square inch, or between 90 per cent and 95 per cent of the average yield point of the material from which the girders were made, which was found to be about 49,000 lb. per square inch.

Buckling of Webs.—The behavior of the web plates during the tests showed a marked difference as between thin and thick plates. The thin plates early in the tests formed into a series of waves or buckles in the length of the girder, the full wave lengths being equal on the average to the depth of the girders, but varying individually in length and position dependent apparently upon the initial contour of the webs. As the tests progressed these waves increased more and more rapidly in amplitude but maintained the same node points. The thick plates on the other hand did not develop any waves, but maintained their initial contours until near the end of the test when buckling occurred at some one point. The dividing line between thin and thick plates in this respect was between the ⅝ in. and the ¾ in. webs. The ⅝ in. webs developed waves similar to, though less pronounced, than those of the ½ in. and ⅜ in. webs, whereas the ¾ in. webs remained stiff to the end of the test like the 1 in. and 1½ in. webs.

Wage Increase in New York Building Trades Since 1916

As a result of increases and bonuses granted recently to 115,000 workers in the building trades in New York City the New York Times estimates that an added labor burden of about $18,600,000 will be borne by building construction in that city during the next 6 months. In discussing this estimate the Times states:

Most of the workers received additional compensation of $1 a day, but increases of $2 a day in the basic rate were awarded the bricklayers, plasterers, hoisting engineers and one or two additional crafts. The estimated increases of $18,600,000 excluded overtime pay, which will probably increase the labor costs in the next six months an additional $1,400,000, making the total wage increase until Jan. 1, 1924, approximately $20,000,000.

A comparison of building trades wages between 1903 and 1923 indicates that the highest percentage increases went to the composition roofers and the house shorers, whose rate of pay in twenty years has increased 264 per cent. The rate of pay for mosaic workers has increased 186 per cent, and next come the bricklayers' helpers, whose rate has increased 185 per cent.

Of the major trades, eleven are receiving more than double the wages of 1916, six trades are receiving twice the amount they received in 1916 and the others are getting a substantial increase. Most of the trade are now being paid $8 to $10 a day with $12 a day for several crafts. Bricklayers, mosaic workers and tile layers are being paid bonuses of $2 to $6 above the scale because of a shortage of workers in these trades.

Increases Since 1916.—The cement and concrete laborers have had ten wage increases since 1916, beginning with $2.80 and going up to $7.20. They received $6.50 a day until a few days ago, when they demanded a dollar increase. The employers offered $7.20 and the men went on strike.

The following trades have obtained the largest of the daily wage increases since 1916:

Bricklayers	$6.00
Stone masons	7.00
Plasterers	6.00
Stone setters	5.50
Composition roofers	5.50
Mosaic workers	5.25
Painters	5.00

One of the outstanding features in the rise of building trade wages has been the value set upon the common laborer. A dollar an hour, or $8 a day, is the pay now awarded common laborers, many of whom ordinarily earn higher wages than mechanics in the skilled trades, who are laid off frequently because of weather and other conditions.

Bricklayers' helpers, who pile the brick and mortar on the scaffolds, receive $1 an hour and have steadier employment than bricklayers, for when the skilled men are laid off on account of rain or shortage of material on the job the laborers are used in the interior of the building to clean up and do other odd jobs. It developed during the recent strike of bricklayers that the laborers assisting the mechanics were quite satisfied with their lot and had no desire to become bricklayers because of the time hazards in the skilled trade. The laborers receive $44 for a 44-hour week, excluding overtime.

Wages in 1903 and 1923.—Here is a comparison of building trades wages in 1903 with the present-day rates and the percentage increases during the last twenty years:

	—Wages—			Per Cent Increase Since
	1903	1913	1923	1903
Asbestos workers	$4.00	$4.75	$10.00	150
Bluestone cutters	4.40	4.50	10.00	127
*Bricklayers	5.20	5.60	12.00	129
*Bricklayers' laborers	2.80	3.00	8.00	185
Carpenters	4.50	5.00	10.00	122
Cement masons	4.40	5.00	10.00	127
†Cement and concrete laborers	2.80	3.00	7.20	164
Composition roofers	2.75	3.25	10.00	264
Electrical workers	4.00	4.50	10.00	150
Elevator constructors	4.25	5.20	10.00	135
Portable engineers	5.00	6.00	12.00	140
Plumbers	4.25	6.00	10.00	135
House shorers	2.75	3.68	10.00	264
Metallic lathers	4.00	5.00	10.00	150
*Mosaic workers	3.50	4.50	10.00	186
Painters	4.00	4.00	10.00	150
*Plasterers	5.50	5.50	12.00	118
Plasterers' laborers	3.25	3.25	8.50	161
Steamfitters	4.50	5.50	10.00	122
*Tile layers	5.00	5.50	10.00	100

*1923 wage is the minimum and excludes bonuses.

†Now on strike for $7.50.

"Submerged Bridge" in India.—A submerged bridge, said to be the largest in India, measuring about ½ mile long, was recently opened in Central India. The bridge, which has been erected across the Nerbudda, is situated between Bombay and Agra, and will be submerged only during high flood.

Specifications From the Contractor's Viewpoint

Abstract of an Address Presented Before Illinois Society of Architects

By WILLIAM F. WISCHMEYER

I know of no subject of more vital interest to the profession, nor one that is approached from so many different angles, than the production of specifications. I shall endeavor to tell you as briefly as possible what I have gained from my experience as chief draftsman and specification writer in the offices of Mauran, Russell & Crowell, and as an estimator and building superintendent in the offices of James Stewart & Co.

I am going to talk on specifications from the viewpoint of a contractor, estimator and sub-contractor, who must estimate on them, as I feel that very few architects are able to obtain this viewpoint unless they have had actual experience in this work. My idea is to bring out the real value of the specification after it leaves the architect's office.

In the contractor's office the estimators call specifications "the vaudeville side of architecture" because of the humorous expressions contained in them. The estimator invariably makes notes of the contradictory things he finds and with his friends gets together and has a good laugh over them.

What Is a Specification?—First of all, what is a specification? Most specification writers define the documents as a description of materials and workmanship entering into the production of a certain type of structure. We learn from this that materials and workmanship form the backbone of the document, while general divisions and notes govern requirements for certain specification work. In discussing the subject it might be well to follow the order in which the specifications are written. First—General Conditions; second—Materials; third—Workmanship.

Speaking of general conditions, I have always liked to define general condition as "obligations" which must be assumed by the owner, architect, and contractor respectively. It has frequently been the case that general conditions were used as a club to brandish over the head of the contractor. Many architects use lengthy general conditions which incorporate much that rightly belongs to the contract agreements, and frequently the conditions of the two documents clash.

General Conditions and Contract Agreement.—The two instruments should be complementary to one another, and should agree in both spirit and letter. We have found that to incorporate a phrase in our contract stating how monthly payments should be made, referring to such and such an article in the general conditions, always takes care of the situation no matter what conditions govern. Often paragraphs are written into the specifications in which the architect binds himself to certain obligations he has no right to assume, later neglecting them, and as proceedings ensue he becomes a burden instead of a protection to his client.

Many architects insert in the general conditions paragraphs which safeguard against many errors or omissions on the part of the contractor, so that the contractor loses interest in work. In my opinion this is unjust, and I have known occasions while estimating when both sub-contractors and general contractors have refused to submit figures due to the unfairness and the confusion in the general conditions. Entirely frank and clear general conditions, without any intention of putting it over on the contractor, never fail to bring in a correct bid. In other words, the general conditions should express the obligations of the contractor and state what he is to include in his estimate in addition to materials and workmanship under the various headings and subheadings.

I have taken from the office a set of general conditions Mr. Russell, Mr. Mauran and myself have labored over. I am not reflecting upon the A. I. A. general conditions. We have gone into them and are not using them, as we feel the general conditions of the A. I. A. are too lengthy. If you were employed in a contractor's office and could see the sub-contractors come in to take off quantities and never look at the general conditions, you would change your opinion. They turn over the pages to their work, take off quantities, make notes of their specification parts, and go on about their business, and then send in the estimate.

We have analyzed many things in

condensing our general conditions to about four pages. At the outset we state what the owner is obligated to do under these general conditions. He reserves the right to reject any and all bids and to let the work to other contractors, and reserves the right to select contractors, paying a preference. He is to make certain payments and take out and pay for fire and cyclone insurance, and to pay for fuel to heat the building only from the time the plaster is dry.

Among other duties, the architect approves samples and materials, examines shop drawings, and issues promptly certificates of payment.

The Contractor's Obligations.—The obligations of the contractors are: He is required to sign a contract to perform the entire work in a satisfactory manner. Where contractors are strangers in the office, we attach our contract form to the specifications, giving them a chance to see the contract they are to sign.

The contractor must select capable sub-contractors only, and shall not settle without the consent of the architect, and shall pay the sub-contractor to the extent of the sub-contractor's interest in the work; he must give the sub-contractor an opportunity to be present and submit evidence in any arbitration; he must be bound to the sub-contractor by all obligations that the owner assumes to the contractor under the general conditions, drawings and specifications; he must be solely responsible for the proper execution of the work and must furnish satisfactory surety bond for a certain per cent of the work; and when required must keep the building heated until the plastering work is completed; must take out and pay for all forms of insurance except fire and cyclone, which the owner will pay for, and be solely responsible for accident or injury to employees or the public.

He must examine and check drawings and specifications, and if discrepancies are found report to architects. He must not require architects to inspect materials out of the city except at the expense of the contractor. He must keep on the work at all reasonable hours a competent superintendent satisfactory to the architect, with full authority to direct the work, receive instructions and give all necessary information that may be required. The contractor must not consider the issuance of certificates of payment as acceptance of the work.

He must keep the building reasonably clean and collect and remove from the premises all rubbish caused by the trades under his contract. He must see that each branch of the work will be installed by persons whose ability to execute it has been satisfactorily demonstrated to the architect. Then there are also paragraphs calling attention to permits, royalties, licenses, fees, municipal ordinances, state laws, and fire insurance bureaus.

That will give you an idea of the general conditions that we have built up in our office. We felt that in this way the contractor would be given the information that would obligate him in the work, and at the same time, wherever it would be necessary, he could make a charge against the contract for it, and I believe there is nothing I have mentioned which would conflict with the general contract. We have had these general conditions and our contract, as drawn up, turned over to lawyers, and they brought back the information that they could see no conflictions in our contract and general conditions.

Next in order is materials. Of all the items in the specifications, I consider it of prime importance to mention the exact kind and quality of material desired by its trade name. Another difficulty is the placing of materials in their wrong classification so that there is confusion as to the trade name, and it often happens that the same kind of material is placed under several different headings. I recall once that when working as an estimator we had to tear down an entire specification and place the materials in their proper positions in order to make an accurate estimate.

Qualifications of a Specification Writer.—Right here I might mention what I think to be some of the qualifications a specification writer should have. He should be well versed in building construction. This requires constant study and a complete and comprehensive catalog file. An architect or designer will have a superficial acquaintance with materials and will use certain materials in design which will not weather well, and it should be the privilege and duty of the specification writer to enlighten him on the subject and suggest proper materials. Such co-operation between designer and specification writer will produce the best results, as I know that designers have very little time to go into the quality of material.

Another important factor is the necessity of keeping in touch with the chief draftsman, gaining through him all of the information required, and seeing that no mistake is made in detailing the work. This supervision will allow the specification writer to investigate the conditions before the final rush to get out the specifications.

The Specification Writer and Materials.—The specification writer should keep in touch with new materials and should make it a point to investigate results of those he has used. He should never fail to visit buildings for which he has written specifications. He should fairly constantly keep in touch with the superintendent and consult him frequently about specifications and drawings and seek information about how he might improve his work. He should consult with contractors and sub-contractors, and never refuse to give a few minutes of his time to all material men.

In this connection a good catalog system is of great value. I fear that many of us neglect material men. I appreciate the fact that if we would allow it, they would come into our offices in droves and bother the life out of us. As a rule, I have these men come in to see me at a certain hour, which I have set aside during the day to get acquainted with new materials. The specification writer should know about materials because he writes about the grades and kinds of materials the designer or draftsman places upon the drawing, and as a consequence he must know more about materials than anyone in the office.

The Specification Writer and Workmanship.—Workmanship, as I understand it, means the skill and the knowledge in the placing of certain materials demanded of the workman in order that the work may be executed in a satisfactory manner. In this connection, the specification writer should discuss with the designer the way in which he wants the materials prepared. For instance, the specification writer may say that the job is to be laid in cement mortar perfect to the line, all joints troweled, weather cut, etc. The designer goes out to the job and sees it and then rushes back to say that he had a cut joint in mind and the workmanship has practically destroyed his entire scheme. This does not mean that the designer should be hampered by the specification writer or chief draftsman, because the design should be studied from every angle before being condemned as being impractical.

How does the specification writer gain this information as to workmanship? First of all, he must be familiar with materials. He should have spent a few years drafting, several years as a superintendent, and should have made it his business to visit as many manufacturing plants as possible to acquaint himself with the manufacturing processes. Then he should place his confidence with reliable contractors and sub-contractors so that he can obtain first-class information from them. It is an excellent plan to visit buildings of high-grade contractors and architects and compare them with similar work of contractors of less ability. The specification writer learns much of workmanship by observation. I think this covers most of the important aspects of materials and workmanship.

Preparing Specifications from Working Drawings.—I want to talk about my method of building specifications from the working drawings. We might at this point consider carefully that the specifications do not serve the architect particularly but that they concern the contractor, estimator, material man, architect's superintendent and manufacturer. Therefore, in writing specifications, these men should constantly be borne in mind. When plans and specifications are ready, the contractor is summoned, given prints and specifications, and is requested to return with his bid at some near future date. If a satisfactory figure is to be obtained, every consideration must be given to the contractor to facilitate his work by describing the work in the most intelligent manner, and fully describing materials in detail as to quality and construction, leaving nothing in doubt. I might mention that I go this far—I refer to catalogs and settle any doubts by referring to an article by its trade name. There have been some questions raised as to this method, but why not refer to an article by its trade name—it saves the estimator a lot of time in looking up catalogs for a thing that fits the general specifications.

I keep in constant touch with the chief draftsman, and when the drawings are approximately 90 per cent completed, I secure a set of prints and a tablet, on which I make a list of general headings in alphabetical order as they occur, placing the name in the

lower right hand corner, and leaving about two or three blank sheets after each alphabetical heading, bearing in mind the trades engaged in the work, and freely consulting my pamphlet on Jurisdictional Awards in selecting the trades.

In dealing with materials which enter into the work, I select my material and place a note on the drawings as to which material has been decided upon, making sure that the information is placed on all sections and in plans and elevations to explain the work more thoroughly. I do not allow draftsmen to place notes on the drawings; in fact, it is absolutely forbidden in our office unless they are requested to do so by me. These sheets of notes which I make are to be kept as record sheets, and my idea in doing this is to avoid conflict after collecting materials in their proper headings on these sheets. After collecting these various materials properly, I assemble the sheets in the order I wish to classify the specifications, numbering with red pencil the notes in the order I wish to call attention to them. I then proceed to dictate the first draft of the specifications, requesting the stenographer to leave plenty of margin for corrections and additions. These sheets I treasure.

In the first paragraph of each heading I call attention to the general conditions. Following this are notes such as alternates, allowances, etc., calling the contractor's attention to items specified in other branches of the work, and under these particular notes the question of hoisting materials is decided. We usually specify that the contractor must hoist all materials at the building or furnish hoist and power, and the sub-contractor is to place the material on the hoist and remove it at the proper floor level. The sub-contractor readily sees he has nothing to do with his material but bring it there and deliver it to the hoist.

The question of work, or scope of work, or work included, is next discussed. The estimator's attention is called to all work specified under this particular heading, placing it in the order as I have numbered the items in red pencil on my notes. The various materials are assembled in order so that when the contractor takes off his quantities he finds his materials all listed in one place and not scattered throughout the specifications.

I next mention workmanship, stating the quality of work we expect in the type of building to be erected, and bearing in mind that a warehouse is not a hotel or a residence and should not require the same quality of workmanship.

Following workmanship, I treat the items under extent of work and describe in detail materials and methods of construction. In carpentry I include the work in general pertaining to carpentry specifications; then from my list of notes explain in detail materials and workmanship in various items. I may discuss the joists and describe them in detail, but I try as much as I can to follow the job through as the work progresses in the building. The estimator likes best to take it off that way.

Under cabinet work, marble work, tile work and similar materials, I specify general items under their proper heading, such as trim, base, architraves, picture moulds, etc. Then when it comes to certain specially designed rooms, I specify that room complete, going on to the next special room for its treatment.

Above all, I avoid the words "or equal" as I find them a bugbear. I never use them in my specifications as I have invariably found there is no "or equal."

During the time I am preparing these preliminary specifications the draftsmen are completing the drawings. When the drawings are practically completed I make sure that all materials are properly noted, selections properly made, and should anything have been added, I make pencil notes on the drawings and have them completed. At the same time I correct the specification draft and turn it over to the stenographer for final writing.

I avoid the practice of sending out letters after plans are issued calling attention to errors, for fear that some contractor may not be reached and will submit his bid without correction. The specification writer should be well versed and accurate and should be responsible for any error in judgment or selection of material.

There is one point I want to emphasize. The architect should realize that the specification writer should really be the man at the head of the drawings. The chief draftsman should control the men and constantly work with the specification writer.

Roofing and Structural Slates

Properties, Principal Features and Suggestions on Standards and Tests Discussed in Paper Presented at 26th Annual Meeting of American Society for Testing Materials

By OLIVER BOWLES,
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PROPERTIES ON WHICH USE DEPENDS

Roofing Slate

Splitting Properties. — True and easy splitting is one of the important properties of a roofing slate. It is generally recognized that slate splits more freely when it is first quarried before the "quarry water" or "sap" has evaporated. For this reason, water is thrown over a block, or it is protected from evaporation by some other means, until splitting is completed. It is claimed, and has been successfully demonstrated, that seasoned slate may be readily split with a slate splitting machine invented by Vincent F. Lake. It would appear, therefore, that when mechanical splitters are employed, the cleavage of slate may be regarded as a more permanent and more stable property than it is now generally considered. The actual physical effect of seasoning on the cleavability is a field of study that has not yet been adequately covered.

Curvature of cleavage planes is not uncommon in slate deposits and is an undesirable feature. Slight curvature may not condemn slate for manufacture into small squares, but prevents its utilization for blackboards and similar products of large surface area. Advantage has been taken of curved cleavage for roofing round towers, but this use is exceptional.

Resistance to Weathering.—Slate consists essential of insoluble and stable minerals that will withstand weathering for hundreds of years. However, small percentages of less resistant minerals may be present. Calcium, magnesium or iron carbonates are slowly soluble in water containing carbon dioxide, and their presence may hasten deterioration. As a rule, a determination of the carbonate present would indicate fairly well the probable resistance of a slate to weathering when exposed on a roof. Some slate in Pennsylvania contains ribbons which consist of narrow original beds usually containing carbon, and darker in color than the main body. There is a tendency for some ribbons to contain an excessive amount of the less resistant minerals and they should not appear on exposed surfaces.

Color Stability.—Slate colors may be fast or changing. The fast colors are due in the main to the presence of iron oxide and other stable oxides. As indicated in the preceding paragraph a change in the color may be due to the oxidation of disseminated carbonates. The terms "fading" and "unfading" are unfortunate, as fading always conveys the implication of inferiority. In some instances the change in color is quite undesirable, in others very pleasing tones of color result. The terms "fast" and "changing" are more appropriate.

Spots and blotches are of common occurrence in the slates of Vermont and New York. Careful chemical and microscopic studies as recorded by Dale indicate that variations in color are due to differences in the proportion of carbonates, pyrite and hematite present. It is probable that decaying organisms embedded in the orginal shale have reduced the Fe_2O_3 to FeO, and the latter has been removed in solution. Usually in the centers of the spots there is an excess of carbonate which may have originated from the shells of the organisms. In general the spots are permanent features that are practically as stable and unchanging as the colors in the main body of the slate.

The oxidation of iron carbonate or of the mixed carbonates of iron, lime or magnesia may cause rusty stains. If the carbonates are evenly distributed they may on weathering change the general color of the entire surface. Stains are also caused by the oxidation of iron pyrite. However, the presence of pyrite is not a sure indication that the slate will stain upon exposure, for some forms of pyrite will remain unaltered for many years. The whole question of the oxidation of pyrite in building stones has been fully discussed by the author in another publication.

Strength.—As slate consists of

overlapping scales firmly cemented under intense pressure, it is remarkably strong. If slates are not split excessively thin they possess sufficient strength for any roofing demands.

STRUCTURAL SLATE

Porosity.—Slate is widely used for sanitary purposes, and for such uses a low porosity is requisite. An average of results obtained by the U. S. Bureau of Standards from many slates indicates a porosity as low as 0.38 per cent. Thus, average slate is well adapted in this respect for sanitary uses, and rejection of slate on the basis of high porosity would imply the attempted use of a very inferior grade, such as slate from a weathered ledge.

Strength.—For certain uses such as steps, lintels, window sills or window and doorcaps, a high transverse strength is required. The peculiar sheet-like structure of slate gives it remarkable strength, a strength far in excess of that possessed by nearly all other building stones. Sandstones are very variable because some are firmly cemented while others tend to be loose and friable. Expressed as the modulus of rupture, the transverse strength of sandstones varies from 350 lbs. per sq. in. for the friable types 6,500 lbs. per sq. in. for dense quartzites, 1,000 to 1,500 being a fair average. A series of marbles shows an average of 2,410 lbs. per sq. in. across the bed. An average of 72 limestones recently tested by the U. S. Bureau of Standards indicates a modulus of rupture perpendicular to the bed of 1,253 lbs. per sq. in. The modulus of rupture of a series of roofing slates recently tested in 8,216 lbs. per sq. in., about five or six times the strength of average sandstone or limestone and three or four times that of average marble. Thus, slate more than satisfies all reasonable requirements for building purposes.

There has been some hesitancy on the part of architects to use ribboned slate for structural purposes, because the clearly defined borders of the ribbon suggest planes of weakness. Theoretically, there should be no weakness along the line of the ribbon, for it represents an original bed, and the complete recrystallization of the mass has developed structures that are entirely independent of the bedding. To obtain definite information on the question, slabs of ribboned slate were recently tested for transverse strength at the Bureau of Standards, and it was found that when breakage occurred the fractures were never coincident with the ribbons but crossed them at various angles. This proves conclusively that the ribbons do not constitute planes of weakness.

Abrasion.—For floor tile or steps, resistance to abrasion is an important requisite. In so far as this Bureau is informed, a limited amount of work has been done in determining the actual resistance of slate to abrasion. Where ribboned slate is used in sidewalks, some of the ribbons, through solubility are worn way as grooves, while others containing an excessive amount of silica stand up as ridges. Such non-uniformity in ribboned slate is an objection to its use, where subjected either to weather conditions or to excessive wear.

SUGGESTIONS ON STANDARDS AND TESTS

Roofing Slate Standards

Standard Thickness.—In free-splitting slate there is a tendency to make slates thin in order to obtain a maximum production from each ton of rock. In consequence, the breakage loss in transit may be high and breakage on the roof may be frequent. This is an unsatisfactory condition for the user, as broken slates are not easily or satisfactory replaced, and new slates may not match in color with the old roof. This reacts on the producer, for broken slates may prejudice the user against slate in general. It is generally regarded that 3/16 in. should be the minimum thickness allowed, and if this were established as a standard it is highly probable that greater satisfaction would exist among consumers, and that the reputation of slate would thereby be enhanced. The thickness should, of course, be a factor of the transverse strength, but until full information is available on the average strength of slates in various regions it would seem advisable to establish a fixed minimum that would cover all slates of reasonable quality.

In fixing minimum thickness, it is not presumed that every slate snall be exactly 3/16 in. thick. Slates are split from natural blocks and are not milled to exact thickness. Slight irregularities may cause the split to run one way or another causing small variations which any specifications should permit. The splitter's chisel with which he measures and determines the thickness should, however, be standardized for 3/16-in. slates.

Standards for Size.—Roofing slates are now made in about 29 standard sizes. It might appear at first sight that the number of sizes is too great and that a reduction in the number would be an advantage to both producer and consumer. There is a widespread movement to reduce production costs by simplifying manufacture, but in the slate industry conditions are entirely different from those that exist in industries where products are molded or built up into finished form. Roofing slates are trimmed to size, and the size is largely governed by the qualities or imperfections of the natural slabs. It may be found that a slate if perfect would trim to 10 by 20-in. size, but on account of some imperfection it may be necessary to trim it to a smaller size. It is noteworthy that if there is a small range of standard sizes, the gaps between them will be relatively large and the waste in trimming down from one size to another will be correspondingly great. A wide range of sizes is, therefore, of definite advantage to the slate manufacturer for it permits him to utilize his raw material to best advantage with a minimum of waste.

A variety of sizes is also an advantage to the roofer. Windy cities require small sizes, also large and massive structures demand larger sizes than are best adapted for small dwellings. Even for the same style of structure quite different sizes are demanded in different cities. Thus in Cincinnati, O., and Galveston, Tex., the principal demand is for 10 by 12-in. slates; in Chicago, 10 by 16-in.; in Columbus, O., 12 by 24-in. A large variety of sizes permits the manufacturer to cater to the demands of all localities.

It is evident, therefore, that nothing is to be gained by inaugurating any movement toward reducing the number of standard sizes of roofing plates.

Standards for Color Stability.—It is unfortunate that some of the trade names applied to slates mask the permanence of their colors. Slate dealers understand the peculiarities of each type, but slate users who are not so well informed are entitled to a set of terms that are descriptive in character and that represent actual qualities. Thus, terms should be employed that clearly distinguish between fast and changing colors.

Standards of Endurance.—The Endurance of slate may be measured approximately by the percentage of carbonates present, but other factors such as porosity may influence it. Where the ribbon is less enduring than the clear slate, standards should be established on this basis. Slate from the zone of weathering near the surface of a deposit should not be used. While slate has been known to endure exposure on a roof for several hundred years, it is unreasonable to expect that material which has been more or less exposed to the ravages of weathering agencies in its natural bed for several thousand years, may give as satisfactory service on a roof as that obtained from the deep-seated deposits. Architects have lately developed great enthusiasm for variegated, highly colored, thick, heavy slates known as architectural grades. The author has observed such slates taken from the zone of weathering where the attractive red, yellow and orange colors were due to excessive oxidation of the iron bearing minerals. Thus endurance was sacrificed for an attractive color. No slate of this character would stand a chemical or microscopic test for enduring qualities, and thus the need is emphasized of establishing definite tests that will protect the user, and incidentally the producer.

Standards for Placing Slate on the Roof.—A product perfect in quality and faultless in manufacture may fail through improper application. Many instances have occurred where good slate has given unsatisfactory service through improper laying. A 3-in. head lap should be the universal standard. While this is generally recognized, some roofers cut down the lap to 2 in. in order to make a square of slate cover more than 100 sq. ft. of roof.

There is a wide difference of opinion as to the best type of nail to use with roofing slates. The nail should be as permanent as the slate, and standards should be fixed for length, diameter, and point, both for new roofs and for roofing over wooden shingles, composition or other materials.

The strength and spacing of supports, the nature of the sheathing, and the use of paper beneath the slates are all matters that have a definite bearing on the quality of the completed roof.

Structural Slate Standards

Absorption.—Slate for sanitary uses should be graded according to its porosity, and satisfactory service

would be promoted by fixing a maximum ratio of absorption.

Strength.—There is a dearth of information on the crushing strength of slate, and except for recent tests made at the Bureau of Standards there is a similar lack of data on transverse strength. As already stated the latter figure is exceptionally high. Wider publicity of this feature would benefit the slate producer, and at the same time encourage the builder to use slate with advantage as a substitute for weaker materials. It is not uncommon to see fractured stones in large structures. Where the strain is excessive it is desirable to establish a high standard which only the strongest natural products such as slate can successfully meet.

Abrasion.—More definite knowledge of the resistance of slate to abrasion is desirable. Some slate stairways long in use are greatly worn, others resist wear remarkably well. The first step in establishing abrasion standards would involve a long series of abrasion tests upon slate from various localities on the basis of the French coefficient of wear. The qualities should as far as possible be expressed in terms that represent actual wearing conditions in comparison with other standard materials used in steps and floors.

Structural Designing. — The best work that has yet been accomplished in slate standards has appeared in a series of bulletins by D. Knickerbocker Boyd of the Structural Service Bureau of Philadelphia, working in co-operation with the Structural Slate Co. of Pen Argyl, Penn. These pamphlets give detailed specifications with plans and elevations of wainscots, stairways, toilet enclosures, laundry tubs, sinks, etc. The object has been to so standardize sizes and designs that ordering may be facilitated, that manufacturing may be simplified, and that standard materials may be kept in stock. The latter feature is an advantage to both producer and consumer, for it saves time in filling orders, and enables the producer to operate and accumulate stock during slack periods. It has also the advantage of giving steady employment to mill and quarry workers.

Trade Schools for Relieving Shortage of Building Mechanics

In a statement issued June 16 James Baird, president of George A. Fuller Co., contractors, and chairman of the emergency committee of the Mason Builders' Association, declared that the problems attendant on the shortage of mechanics in the building trades in New York would be solved if the owners of the $100,000,000 building projects now delayed by scarcity of skilled labor would invest $500,000 to establish schools for training mechanics. In an analysis of the present situation, coupled with a survey of the number of bricklayers now at work, made by the Mason Builders' Association, Mr. Baird said that the extent of the building that can be done at any time in New York is limited by the amount of work that can or will be done by 3,500 or 4,000 resident bricklayers. Mr. Baird's statement follows:

The Emergency Committee of the Mason Builders' Association has just completed a careful survey covering all building operations in Greater New York (the exact number being 781). This survey has developed the fact that the total number of bricklayers working in Greater New York on June 1 was 4,642.

Further inquiries indicated that approximately 500 men were not working, due either to illness or lack of inclination. This demonstrates that the number of available bricklayers at present in Greater New York is approximately 5,000. Of this number, the reports indicate that from 1,000 to 2,000 are transients. In other words, the building that can be done in New York is limited by the amount of work that can (or will) be done by approximately 3,500 or 4,000 resident bricklayers, though in times like the present, when bonus payments are added to the basic wage, an increment known as "floaters," to the extent of 1,000 to 2,000 (depending upon the amounts of the bonus paid) comes to the city.

The Need for More Bricklayers.—The entire country has a shortage of trained men in the building trades. The records of the Department of Labor for a 10-year period are:

Classes of Mechanics—	1910	1920
Brick and stone masons	161,000	131,000
Plasterers	47,000	38,000
Roofers and slaters	14,000	11,000
Stonecutters	35,000	22,000
Painters, glaziers, varnishes	273,000	248,000
Total	530,000	450,000

The table shows a decline of 80,000 skilled workmen when there should have been an increase of at least 100,000 to keep pace with the growth of population. One of the chief reasons for this shortage of mechanics lies in the policy of labor unions of enforcing onerous rules and conditions which have had the effect of restricting the number of apprentices.

The result has been that the requirements for building construction in Greater New York (as well as practically throughout the country) are not regulated by the needs of the industry and of the public, but by a small group of workers, the number governing the situation in New York being certainly not more than 4,000, since the bricklayer is the key to the building situation, and the shortage in this trade controls the program.

This group has followed the principle that it will not materially add to its number and will fill just as much of the building requirements as the organization is pleased to do and at rates and under conditions that it is in position largely to regulate.

This is a condition that can and must be corrected. And how? Similar situations are now being met in many cities throughout the United States, particularly in the West, where schools for training building mechanics are in operation, notable examples being Cleveland, Chicago, Los Angeles and San Antonio. In San Francisco there are seven such schools. While there are a few very small, inadequate schools scattered through the East, there is none of anything like sufficient capacity.

The method of expediting work in New York has been for a builder who requires men to go across the street to a competitor's job and offer a higher wage. One of the leaders in labor comments on this by asking, "What could be expected of a workman when a contractor meets him coming off work and invites him to come across the street to his job for twice as much money and half as much work?"

This gets no more building done, but it adds to the cost to the public, and some other remedy must be found.

The Training School Plan.—Besides the 2,000 to 4,000 additional bricklayers needed in New York there are proportional added requirements in other trades. Training schools are needed. I may suggest a way in which the necessary schools could be supplied. A committee of public-spirited citizens could raise the necessary funds (the amount needed certainly not exceeding $500,000) to secure quarters and instructors competent to train the necessary number of young men much more easily and expeditiously than it was during the war to train a much smaller number of young men as soldiers. Young men can become fairly good working machanics, in most of the industries, within a six months' period, after which they can be further instructed in the finer details for a period of perhaps two years, and during this time they can also be working producers at good pay.

The fact is so obvious that there is a shortage of trained mechanics in New York that in all probability the unions would not contend against taking trained men into their organization as fast as they are developed. If the unions should refuse, then, of course, the young men that are trained would of necessity have to undertake work on their own account, following which the unions would without doubt take them into their organizations immediately.

As there is at present work in New York to the extent of, say, $100,000,000 help up waiting an adequate supply of mechanics, it can readily be seen that an investment of $500,000 to establish training schools would be money well invested. I would urgently suggest that the situation be considered by a committee appointed by the business interests of New York now affected by the shortage of men.

As to stability of employment at good wages, it is obvious that if an adequate supply of mechanics were continuously available in the City of New York, wages would remain stable, for there would be no unnecessary bidding among the contractors on a "snowballing" basis. Nor would there be the dissatisfaction and inclination to strike among the workers.

So far is the country behind in its building, so rapidly is the country developing and its population increasing, and so great is the volume of new building needed to replace worn out or obsolete buildings, that employment would remain continuous indefinitely. The shortage problem can be solved in the very simple way suggested; but unless it is solved, the menace not only in the building industry but to all industries will become perpetual.

How the Quantity Survey Works in Milwaukee

Results From a Practical Survey Bureau Conducted By General Contractors Described in The Constructor

By S. H. EIGEL,
Manager, Bureau of Quantity Survey, General Contractors Association, Milwaukee

This article has been written in response to numerous requests from contractors throughout the United States, who are members of the Associated General Contractors, and who are contemplating organizing a Survey Bureau within their local associations.

It presents a practical survey bureau operated and maintained by general contractors in Milwaukee County, Wisconsin, which is successful and which has been in operation for the past 12 years and is still going strong.

It is not the purpose in relating the facts as to the method of operation to have the readers presume that a bureau operated by contractors is ideal, but it is desired to convey the thought that the Milwaukee Bureau is practical, successful, and in a healthy financial condition. The fact which undoubtedly is most prominent and most worthy of consideration, is that we are helping to overcome prejudices which may exist and promoting the idea which is the forerunner in establishing the thought of quantity survey bureaus in the minds of all engaged in the building business, and eventually and finally placing all of the practical material in a position to be of use for further development.

Quantity Survey Bureau.—Quantity surveys may truly be called one of the A-B-C's of the construction business. It is evident that contractors throughout the United States, particularly those affiliated with the A. G. C., are beginning to see the necessity of learning their A-B-C's well in this respect. Milwaukee contractors some 12 years ago organized the General Contractors' Association and in connection with it established and have operated a survey bureau. The proof of its success is measured by its existence today. A brief outline as to our method of operation will no doubt be of benefit to contractors who are contemplating a similar movement.

The scope of our work has been confined to the following items:

1. Excavation.
2. Concrete (plain and reinforced).
3. Reinforcing steel.
4. Mason work.
5. Accessories in conjunction with concrete and mason work such as setting of miscellaneous steel and iron, cut stone, terra cotta, etc.

General contractors only who have been in business for at least two years, are admitted to membership.

Service Charges.—An estimating fee has been established on all work in excess of $5,000. These charges have been arranged according to a schedule and classified in percentages which are as follows:

Size of Project.—$5,000 to $100,000, 0.5 per cent to 0.3 per cent.

$100,000 to $300,000, .3 per cent to 0.2 per cent.

$300,000 to $1,000,000, slightly less than 0.2 per cent to 0.1 per cent.

$1,000,000 to $3,000,000, about 0.1 per cent.

A schedule of fixed charges has been adopted. The above percentages are a close approximation of them.

The above charges consider only the amounts for excavation, concrete and mason work, and are payable 30 days after signing of contract by the successful bidder.

Rules Followed.—It necessarily follows that as a forerunner to maintaining a practical survey bureau in a contractors' association, certain rules must be definitely established which regulate the manner of taking off quantities.

A fixed set of take-off rules is a first consideration for all those contemplating a survey bureau to be operated by a local association, in which all contractors in the association participate, and a committee or any person capable of drawing up a set, should be appointed to do so. After the rules have been temporarily estab-

lished final action should be taken in an open meeting in order that uniformity of take-off shall be established. Take-off sheets should be standardized, as well as the completed survey.

The names or the number of bidders on any project must not be disclosed from any source within the bureau.

Accuracy Through Checking Back.—Our experience has clearly demonstrated that, though the greatest care is exercised in endeavoring to furnish quantities free from error, at intervals mistakes will occur and perfect quantities may be obtained only through a system of checking back.

The membership of our association ranges between 15 and 20, and survey operations are principally in Milwaukee County. On practically any job of consequence, there are at least four, five or six bidders who are members of the survey bureau figuring the project.

Should a difference occur, or should one of the members figuring feel that error exists, he will call the bureau, notifying it of the difference. The bureau will then check back, and, if error exists, all contractors who have obtained the quantities will be notified, whether they have been parties to the discovery of the error or not. A system of this kind practically assures correct quantities.

Many errors, misinterpretations, omissions of material, etc., have been detected through the medium of the survey bureau, and we sincerely believe that the bureau is partly an inspiration for the furnishing for more complete plans and specifications, which in itself is an important factor.

Only general contractors who have been invited to bid by the architect or owner are entitled to receive quantities.

We do not operate for profit, that is to say, all members in good standing are entitled to a refund in proportion to the amounts which they have paid in, after all expenses for maintaining and operating the bureau have been deducted. These moneys are not distributed every year, but disbursed at the discretion of the board of directors, usually after the accumulation of a surplus fund.

At the close of 1922, we returned a portion of the accumulated moneys to the members.

Cost of Bureau Operation.—From January 1, 1922, to January 1, 1923, the total number of surveys furnished to members by the Bureau for the items of execavation, concrete and mason work were as follows:

Warehouses, factories and garages	31
Apartments	13
Stores and offices	22
Schools	17
Churches	5
Hospitals, lodges and clubs	9
Residences	4
Bank and theatre	2
Grading, bridge and foundation	3
Total	106

Forty-one of these projects were obtained by bureau members, 44 obtained by contractors outside of the association and 21 jobs were postponed.

The total volume of excavation, concrete and mason work obtained by Bureau members, in dollars and cents, amounted to between $2,500,000 and $3,000,000.

The operating cost to execute the volume of work mentioned amounted to about $10,000—of this amount $7,000 to $7,500 applied to salaries and the balance was for general overhead, light, phone, rent, etc. The salaries mentioned are for two estimators and one stenographer.

A calculating machine and mimeograph outfit for making take-off forms, completed survey sheets, etc., should be part of the office equipment.

Opposition Overcome.—When our bureau was first organized, it met with opposition from many of the architects and engineers, but that day is past, and I daresay there is hardly an architect or engineer doing business in Milwaukee County who will not co-operate with our survey bureau and who is not willing and ready at all times to give due consideration to it in the matter of plans and specifications and postpone the closing of bids, if necessary, if the Bureau has not had the plans.

Architects and engineers are beginning to realize that survey bureaus are looming up as a necessary accessory to the building business. Owners of building projects are beginning to take cognizance of it. In other words, we are helping every day to break the ice in the proper direction.

To associations contemplating survey bureaus, it will undoubtedly be easier to gain recognition from architects and engineers on account of the pioneering which has been done, and

by reference to communities, where the custom is established.

Agitation and propaganda are needed and where enough has been obtained, no doubt the work will be earnestly considered in the proper channel. The only way sufficient propaganda and agitation may be obtained is by starting something.

We are not of the opinion that quantity surveys make new contractors, but are firmly of the opinion that they make better contractors of those already engaged in the field because of the fact that the detailed items are more fully covered.

A quantity survey in itself is but one phase of the contracting business, and any man who contemplates going into the business because of the fact that he can obtain a survey is merely parting with his money. If it is his intention to venture into the business, he will do so regardless of that fact, and if he does, the contractors already in the field will undoubtedly have better competition because of the quantity survey.

Safe Profits.—Considerable of the guess, gamble, litigation, misinterpretation of plans, specifications, material, etc., will be eliminated when we have reached the goal for which we are striving. A more sincere feeling of co-operation, a pleasanter and more congenial atmosphere, will prevail when we know that quantity surveys will accompany the plans and specifications, and with it eventually will come the guarantee which many are looking for.

On a certain building project in Milwaukee, the City Engineer's office furnished a set of guaranteed quantities with the plans and specifications, and on several other building projects quantities have been furnished as being reliable but were not guaranteed, but served as a good basis for checking and feeling safe.

If one really and truly wants a certain anything in this world and feels that he earnestly needs it, should it be the custom to call in a third party to give a price on it without the third party having a definite detailed knowledge of the requirements. This may seem a crude way of putting it, yet that is a condition met with in many plans and specifications. The fact that one has a reputation of being a good speculator and sport, and having taken losses before, does not constitute a reason for continuing in this path.

Apprentices and Craftsmanship in the Building Trades

Remarks Made At the 56th Annual Convention of the American Institute of Architects in Washington, D. C.

By D. KNICKERBACKER BOYD.

At the many meetings which we have had of the Philadelphia Building Congress we have almost always come down to the one subject, that of the lack of apprentices, and the need of apprenticeship training in the building crafts. These conditions seem more accentuated today than ever before, because of the recent great increase in the amount of building construction. Notwithstanding this, the facts are that during the last 10 years the number of workers in the building trades has constantly decreased, while, with the exception of the period following the war, building itself has greatly increased, so that you see the situation we are confronted with today is quite a natural one. But it should have been recognized long ago.

Now, when we consider the problem of the apprentice in the building trades—or crafts, as I prefer to call them—and debate whether the fault lies with those who, it is often claimed, are endeavoring to restrict the number of apprentices or with the employers who it is also claimed are not willing to assume the responsibility of training young men, we have before us quite a large subject. And what we need, as architects, I firmly believe, is to devote more attention to craftsmen and not give all our thoughts to draftsmen, although we do need still to do much for the latter.

The "White Collar" Day.—The difficulty seems to be, notwithstanding the two claims made, that the boys do not exist in sufficient numbers who want to learn the crafts and trades. The young men of today do not seem to want to enter what they consider the "laboring" field. So why go into protracted academic discussions as to who is responsible for the lack of numbers? We need to discover the cause of the lack of interest on the part of the boys.

We must inculcate the idea in the young men of America that the crafts do offer a future for them, and we must stimulate in their minds a desire to achieve something dignified and

definite with their hands. The craving of every human being to create and accomplish can be satisfied through craftsmanship properly appreciated.

The present difficulty does not rest so much with the boys, it seems to me, as it does with many of their parents, and with most of the educational systems of the country. Traced back into the homes of the children, I really believe that the fault lies more with the mothers, sisters and sweethearts of the young men and boys, than it does with almost anyone else. These dear ladies, most of them, do not want to see their boys, brothers or "boy friends" dressed in overalls or the clothes of workingmen, and littered with mortar, plaster, sawdust, metal filings or paint. They do not seem to like that and they therefore use their persuasion on their relatives and friends to keep them from training for or engaging in this sort of work.

We, therefore, feel as we see it in Philadelphia and as I have observed it throughout our movement elsewhere, that we can, as a group, accomplish definite results, and as individual architects, achieve something by directing our energies with equal force to the present journeymen problem, as well as to the apprentice.

"I Don't Want My Son to Follow My Trade."—After all, the greatest discourager of the boy who might want to become an apprentice in the building trade can be, and most frequently has been in recent years, the father who is now working in the trades. Fathers, uncles or relatives who are employed in the so-called building trades at this time will generally not urge or encourage their sons, nephews or other young men to enter the same calling.

The journeyman of the present generation now working on the buildings we design realizes that he has lost much time in the Eastern and other sections of the country subject to cold climates, through seasonal losses of occupation. He has, in normal times, been subject to intermittency of employment and he has been working at what is almost always rated a hazardous occupation. He is frequently working out doors, subject to attendant disadvantages as well as advantages. His task is often a very heavy one and involves a difficult piece of work, and in spite of the skill required and art he many times displays, he tells his boy not to learn that trade. These men can be the greatest enemies of the building crafts today. I think the fault lies partly with the construction groups, the public and with us as individual architects.

Locally and nationally, studies of all the difficulties involved can be made and conditions alleviated through cooperation of all, including the public, by a sensible distribution of its new construction and maintenance requirements.

The Architect's Part.—As for our part as individuals, if we architects recognize the fact that we are, as our very name implies, master craftsmen, it seems to me that we ought to be able each to accomplish our part in improving the status of other craftsmen by encouraging and giving recognition to the "workers on the job." It is these men who, as a matter of actual fact, assume their part with us in securing the results which we are striving for when we design our buildings and write our sometimes hazy specifications.

Many of us, if we look back through the years of our superintending, will perhaps realize all too suddenly that we have usually passed the worker by —that he has not been given sufficient recognition for services well performed. We all have to condemn work sometimes—but how much oftener, when it should be commended, do we do so? That, it seems to me, is one of the faults to which we can address ourselves, and we can very readily correct it if we will give heed to the human side of our own industrial relations. If our contact with the workers on our buildings is such that they know that real interest and good work will cause favorable comment, we will encourage them and help them to believe that which they may often be justified in doubting, namely, that what each is doing is, if well done, an accomplishment worthy, often, to be called an art.

How the Worker Can Be Given Recognition.—The consciousness on the part of each that what he does is something vitally important to the success of the whole design and fabrication will cause each to feel that he must qualify as a craftsman, and not be content to consider himself merely one of a "gang" working on a "job."

I would like to give you one typical illustration of an actual experience in this direction:

Just before I left Philadelphia I attended the opening of an exposition

there called the Palace of Progress. For this exposition there has been built under my direction one of the numerous buildings called the "model home." The management consented to issue a book descriptive of the materials used, with which we should all be more familiar than we are. It was also decided to list the name of every man who worked efficiently night or day to make that building a success.

In keeping the records to give this recognition to the craftsmen and workers, I asked some of the bricklayers what the names of the men were who worked with them in their particular craft. I said to them, "How about the mortar mixers and the hod carriers?" One of the bricklayers said, "My God! you don't want their names, do you?" (Laughter). I said, "Why certainly! You men must admit that you can't successfully perform your work, nor can the architect get the best results for the owner if you don't get good mortar and if you haven't got good, strong shoulders to carry the mortar and bricks to you and place them efficiently for you. I consider those men very important to the rest of us."

The bricklayer said, "We only know them by their numbers, as 1, 2 and 3. That man over there is No. 2," (indicating). I had to go to the man and get his name personally, which I was glad to do, though it caused much astonishment on his part as to my purpose.

As a result of that talk and others, and of the fact that these men were going to be given recognition in the book, many of them who had been working day and night during two weeks said, "We will not accept any excess pay for the overtime or the night work, because our efforts to please the public are being recognized." (Applause).

The Advantages of Fair Recognition of Workers.—I have often talked to workers collectively and individually and asked them if, they should be requested to express one wish that they would like to have gratified more than any other, what that wish would be. They have all said, strange as that may sound to some, that what they wanted most was some fair recognition for their work—or as they have put it—a few words of appreciation for work well done when they try to do their best.

In that direction we, as architects, can take advantage of many of the opportunities that our calling presents. We can surely appreciate the human factor and stop and talk with the men. They can work with us and not for us, and we can both learn and teach if we say, "Well done, old man," or Tom or Dick or Harry, or whoever he may be, if his methods and results appeal to us.

We may not always be in a position to say that they are doing their job well, for they may know it a great deal better than we do, but we certainly can let them know at least that they are giving us the results that we have tried to provide for in our designs and that they are correctly interpreting what are sometimes, perhaps, vague specifications which could be much improved as Mr. Jones so well told us yesterday.

It seems to me, therefore, that the problem can be rightly solved and in part almost immediately solved if we can begin at once to improve our specifications, our methods and ourselves and by real human contact restore interest and pride of craft.

If we make the workers feel that we recognize their part as real factors in the success of any enterprise, that their efforts and the results of their work form a large part of the success of our work, and the satisfaction of our client—if we do that, the apprenticeship problem will largely solve itself.

I would like to suggest, however, in view of the points raised during this convention on the apparent lack of apprentices, that some step might be agreed upon whereby the Industrial Relationship Committee could appoint a sub-committee on Apprenticeship. In its title I would, however, include Vocational Guidance, because the fault, it seems to me, lies largely with the lack of guidance toward manual labor in the schools.

I believe that the Institute could do nothing of much greater value than to create such a committee if through it a new Document might be prepared which could well be entitled "The Romance of Building," and be made available to the schools everywhere. In this booklet could be portrayed intelligently and enthusiastically, the advantages of being a worker on a building and of having an opportunity to co-operate with architects and all other craftsmen in being of ever increasing service to the people of this country.

New Type of Pre-Cast Concrete Construction

Results of Tests of Reinforced Concrete Beams Given in The Carnegie Technical Journal

By F. M. McCULLOUGH,
Professor of Civil Engineering, Carnegie Institute of Technology

The constantly increasing cost of forms, due to advances in the price of lumber and in wages of carpenters, has led many types of pre-cast concrete construction in recent years.

The pre-cast units usually consist of the following types:

1. Beams, slabs, columns, etc., in which is embedded properly designed reinforcement.
2. The ordinary tamped or poured concrete block which has no provision for reinforcement.

The Henderson Corporation of Pittsburgh, Pa., has recently developed a unit out of this latter type. In October, 1922, three reinforced concrete beams built of these units, which are called universal building blocks, were tested in cross-bending for the Henderson Corporation in the Materials Laboratory of the Carnegie Institute of Technology by Professor F. A. Simmons and the writer.

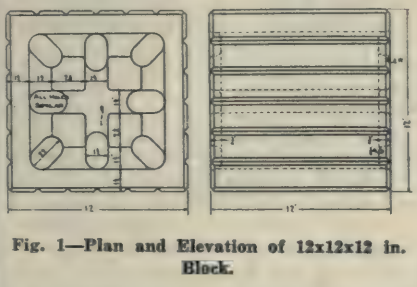


Fig. 1—Plan and Elevation of 12x12x12 in. Block.

General Features of the Blocks.—As several new features are included in the shape, manufacture and use of the blocks, these features will be first described in order that the report of the tests may be more clearly understood.

The units made under the Henderson Construction System consist of blocks and specials. The blocks vary in size from 12 in. x 12 in. x 12 in. long to 4 in. x 4 in. x 12 in. long with a few 9-in. and 6-in. lengths. The specials include caps, reducers, brackets, angles, corners, etc.

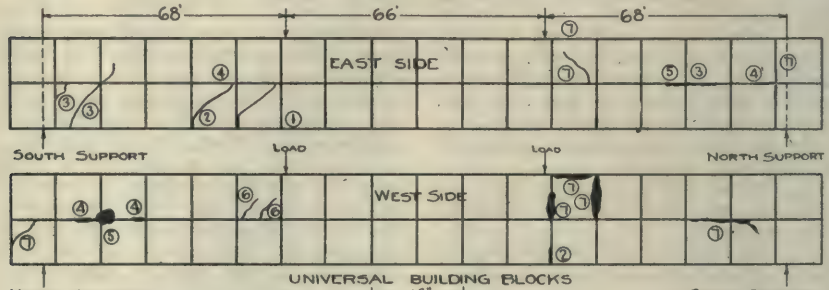
The units are made of portland cement, and the ordinary fine and course aggregates of portland cement and pulverized blast furnace slag may be used. The mortar is placed in molds and in machine tamped to a pressure of about 500 lb. per square inch. After the molds are removed, the blocks are subjected to a steam-curing process.

The block has a number of holes near its outside surface, the number of holes increasing with the size of the block. The holes extend between the two end faces and are parallel to the axis of the block. These holes may be used for steel reinforcement if it is required, and they are of sufficient size so that the reinforcement may be surrounded by a rich portland cement grout. The oval shape of the hole provides for lapping the steel bars. In the end faces of the block and connecting the holes are recesses in which stirrups may be placed and grouted. Fig. 1 shows a 12-in. x 12-in. x 12-in. block in plan and in elevation.

Construction of Beam.—In constructing a beam, the required number of blocks is lined up on a flat surface, the stirrups are placed in the recesses at the ends of the blocks, and all surfaces in contact are brushed with a grout. The horizontal steel is now placed, the T-shaped plates are put in a position on the two blocks at the ends of the beam, and the nuts on the horizontal steel bars tightened against the end plates to give an initial tension in the bars. Grout is now poured around the horizontal steel and the stirrups through openings chipped through the blocks in the middle of their top joints. When the grout has set, the beam is hoisted in place, the end plates are bolted to plates in connecting members and all exposed plates and nuts are grouted. Vertical members such as columns, poles, etc., are built in a somewhat similar manner. This construction may be carried on at the factory where the blocks are made or the blocks may be shipped to the site of construction where they may be assembled to form the different structural elements.

Tests of the Beams.—The following is taken from a report of the tests of the beams which was mentioned in a previous paragraph:

The beams were built of Universal Building Blocks, 12 in. x 12 in. x 12 in., and were about 18 ft. long. The span varied from 16 ft. 8½ in. to 16 ft. 10 in., and the load was applied approximately at third points. The amount and position of horizontal reinforcement, the cross-section of the beams, the span and position of the loads and the development of cracks during the test are all shown in Figs. 2, 3, and 4. The number of a crack agrees with the number of the load at which the crack appeared; thus crack No. 1 appeared



UNIVERSAL BUILDING BLOCKS

Load Nº	Total Load In Lbs. Includes Wt Of Concrete
1	44090
2	60590
3	65090
4	74590
5	78090
6	79650
7	83890 Ultimate

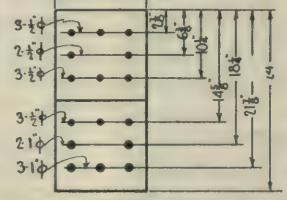
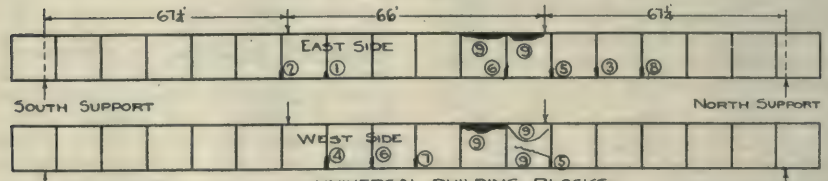


FIG. 2 BEAM Nº 1



UNIVERSAL BUILDING BLOCKS

Load Nº	Total Load In Lbs. Includes Wt Of Concrete	Load Nº	Total Load In Lbs. Includes Wt Of Concrete
1	11665	6	14215
2	12175	7	14865
3	12965	8	17640
4	13915	9	23565 Ult.
5	14015		

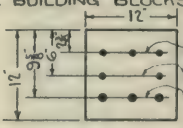
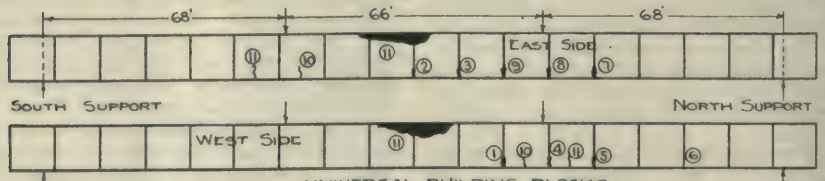


FIG. 3 BEAM Nº 2



UNIVERSAL BUILDING BLOCKS

Load Nº	Total Load In Lbs. Includes Wt Of Concrete	Load Nº	Total Load In Lbs Includes Wt Of Concrete
1	7440	7	12115
2	8140	8	12515
3	8315	9	19350
4	9890	10	21940
5	10265	11	23040 Ult.
6	10710		

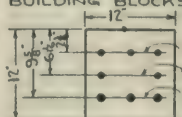


FIG. 4 BEAM Nº 3

Figs. 2, 3 and 4—Reinforcement, Cross Section of Beams, Span and Position of Loads and Development of Cracks.

at a load of 44,090 lb. in Beam No. 1, Fig. 2. The blocks were reported as having been made during the latter part of August, 1922. The weight of the 12 in. x 12 in. beams was assumed to be 2,700 lb. and that of the 12 in. x 24 in. beam, 5,400 lb. This corresponds to a weight of 150 lb. per cubic foot. All computations are based on the ordinary straight-line theory.

Test of Beam No. 1.—This beam was 12 in. wide, 24 in. deep, and had single loop, ½ in. round stirrups spaced 12 in. apart at the joints between blocks. The beam was assembled Sept. 8, 1922, and tested Sept. 22, 1922. The superimposed load at failure was 78,490 lb. and the weight of beam was 5,400 lb., giving a total load at failure of 83,890 lb. The bending moment corresponding to this total load is 2,794,000 in. lb.

The bending moment of an ordinary reinforced concrete beam having the same cross-section and the same reinforcement, neglecting any effect of end plates, is 744,000 in. lb. for a working concrete stress of 650 lb. per sq. in. It seems reasonable to base the factor of safety for this beam on the ratio of its actual bending moment at the maximum load to this computed bending moment at a stress of 650 lb. per sq. in. in the concrete. On this basis, the factory of safety is equal to

$$\frac{2{,}794{,}000}{744{,}000} \text{ or } 3.8.$$

The maximum tensile stress in the steel corresponding to a stress of 650 lb. per sq. in. in the concrete is 11,820 lb. per sq. in. This indicates that more tension steel was used than necessary.

The failure was due to the crushing of a concrete block in the upper half of the beam and just outside of the third point load. (See No. 7 in sketch of West Side of beam, Figs. 2 and 5). Numerous diagonal tension (shear) cracks developed. (See No. 3, No. 4, and No. 7 on East Side and No. 6 on West Side). Inclined crack No. 3 opened very wide during the latter part of the test and for a time it appeared that this crack might cause failure. Small cracks appeared at several vertical joints but did not increase in size to a greater extent than in an ordinary reinforced beam. A few horizontal cracks opened up between the upper and lower layers of blocks. (See No. 3, No. 4, and 5 over north support on East, and No. 4 and No. 5 on West Side). These cracks did not affect any considerable area of the horizontal joint.

Test of Beam No. 2.—This beam was 12 in. wide, 12 in. deep, and had single loop, ½-in. round stirrups 12 in. apart at the joints between blocks. The dates of assembling and testing of the beam were Sept. 6, 1922, and Sept. 23, 1922, respectively. The superimposed load at failure was 20,865 lb. and the weight of beam was 2,700 lb. giving a total load at failure of 23,565 lb. The bending moment corresponding to this total load is 763,500 in. lb.

The bending moment for an ordinary reinforced concrete beam having the same cross-section and the same reinforcement, neglected any effect of end plates, is 172,900 in. lb. for a working stress in the concrete of 650 lb. per sq. in. The factors of safety obtained as explained under Beam No. 1 is

$$\frac{763{,}500}{172{,}900} \text{ or } 4.4.$$

The maximum tensile stress in the steel corresponding to a stress of 650 lb. per sq. in. in the concrete is 9,150 lb. per sq. in., thus indicating a greater amount of tension steel than necessary.

The failure was due to the crushing of the upper part of two blocks just inside of the third point load. (See cracks No. 9 in sketches of East Side and West Side, Fig. 3). Only one inclined crack was noted. A few small cracks at the joints were observed.

Test of Beam No. 3.—This beam was similar in size to Beam No. 2 and had the same amount of horizontal reinforcement, but had no stirrups. The beam was assembled Sept. 5, 1922, and tested Oct. 13, 1922. The superimposed load at failure was 20,340 lb. and the weight of beam was 2,700 lb., thus giving a total of 23,040 lb. The bending moment at this total load at failure was 754,500 in. lb. and the factor of safety, computed as for Beam No. 2 was

$$\frac{754{,}500}{172{,}900} \text{ of } 4.4.$$

The maximum tensile stress in the steel for a stress of 650 lb. per sq. in in the concrete was 9,150 lb. per sq. in., thus indicating more steel than necessary, as was the case in Beam No. 2.

The failure was caused by the crushing of the upper part of the two blocks at the center of the beam. (See

crack No. 11 at the top of the beam, Fig. 4). No inclined cracks were observed. Several small vertical cracks appeared at the joints and one vertical crack was seen at the middle of each of two blocks. (See vertical cracks No. 10 and No. 11.)

Conclusions.—The outstanding feature of these tests was that the crushing strength of the blocks limited the strength of the beams and that therefore an increase in the crushing strength of the blocks would increase the strength of the beams. This increased strength of the blocks might be obtained by increasing the proportion of cement, or by a more careful selection of the aggregate or by improving the methods of manufacturing the blocks. (The ordinary materials and methods of manufacturing were used in making these blocks).

It will be noted that the 12-in. x 24-in. beam showed a dangerous diagonal tension (shear) crack just before the concrete block failed by crushing. It would seem advisable for beams of this cross-section and span, providing the compressive strength of the blocks is increased, to also increase the amount of stirrup steel either by increasing the size of stirrups or the number of stirrups.

A comparison of the loads at failure of the two 12-in. x 12-in. beams indicated that the stirrups did not appreciably increase the strength of Beam No. 2. This may be explained by the fact that no diagonal tension cracks appeared in Beam No. 3, and only one in Beam No. 2. The ratio of length to depth for these beams (No. 2 and No. 3) was so great that the unit shearing stress was not sufficient to cause diagonal tension failure. However, if the strength of beams of this cross-section and span is increased by increasing the crushing strength of the concrete blocks, then stirrup reinforcement would be necessary. Furthermore, these stirrups should be spaced at a distance apart not greater than one-half the depth of the beam.

The factors of safety obtained by dividing the bending moment at failure by the bending moment corresponding to a unit stress in the concrete of 650 lb. per sq. in. average about 4. The factor of safety for the ordinary type of reinforced concrete beam obtained by dividing the bending moment at failure by the bending moment corresponding to a unit stress varies from 4 to 4.5 for 1:2:4 concrete in the concrete of 650 lb. per sq. in. at an age of 28 days, and therefore it may be stated that the beams tested compare very favorably with ordinary reinforced concrete beams in regard to factor of safety. Any increase in the quality of the concrete blocks should increase the factor of safety.

It was apparent that no serious movement of the upper layer along the lower layer of blocks occurred in Beam No. 1. While a few cracks appeared along the horizontal joint, they were not in any sense continuous over the length of the beam. Doubtless the stirrups and the surrounding grout assisted the brush coat of grout between the blocks in preventing a horizontal shear failure.

It will be seen that the maximum tensile stress in the steel corresponding to a unit stress in the concrete of 650 lb. per sq. in. varies from 9,150 to 11,820 lb. per sq. in. Thus the beams are stronger in tension than in compression. Since these stresses are considerably less than the stress of 16,000 lb. per sq. in., which is ordinarily used for steel, it is evident that these beams are too heavily reinforced and that some economy would result if the amount of tensile steel were reduced. However, if the strength of the concrete blocks is increased by improved methods of manufacture, then it will be necessary to use a fairly high percentage of reinforcement in order to secure a beam equally strong in tension and compression.

The vertical cracks which opened up between the blocks were no larger than those appearing during the test of an ordinary reinforced concrete beam.

Fire Tests of Roofing Materials

The U. S. Bureau of Standards has prepared a program of tests, equipment is being procured, and test specimens constructed for conducting a series of fire tests of roofing materials with particular reference to the relative merits of wood shingles and prepared roofing. A conference has been held with representatives of the wood shingle manufacturers, the prepared roofing manufacturers, and the fire underwriters, at which agreement was reached on the methods of testing, and on an outline of the program of tests.

Models in Architectural Representation

Advantages of Cardboard Modeling Described in The Kansas City Engineer

By GILBERT L. GEERY

The position of the architect is peculiar, for it is the custom of his profession to sell first and then to produce. The masters in each of the allied arts invariably produce or create first, and then sell the product; but it is not so in architecture. The architect finds that he must sell to his client something yet to be erected or constructed from the usual plans and specifications. It is becaue of this peculiar situation that the architect finds it difficult to sell to his client. He must represent, to his client's satisfaction, the proposed work before he can realize on his ideas. And it is in this method of representation that he meets his biggest problem.

The Different Viewpoints of Architect and Client.—Now the architect is accustomed to thinking and drawing in three dimensions. The client most likely is not. The drawings appear to the architect as an expression of some actual structure, standing out from the paper in all its dimensions; whereas to the client they may appear only as a maze of lines that represent nothing. It is of course difficult for the architect to believe that what appears to him as so simple a representation should be unintelligible to another, and yet that other is the man with whom he must do business. How, then, can the architect get his ideas "across?" How can he get the client to see the finished product as he himself sees it?

At present there are two ways. Perspective views enable the architect to give his client an idea of the appearance of the building as viewed from a few defined station points, but at their best, perspectives fail. The model seems to be the ideal method of representation. Though the use of models is not new in architecture, it is only of comparatively recent date that cardboard models, easily and cheaply constructed, have been used successfully, and it is with this type of modeling that we shall be chiefly interested in this discussion.

Scale Models from Cardboard.—Cardboard modeling is an art that is still in its infancy. It is receiving a lot of attention, and the near future will undoubtedly see a marked development. As soon as the public—the artistic public—learns that it is practical for architects to furnish scale models as a part of preliminary sketches, it will demand that they do so, and will choose the architects that furnish them, even if their fees are higher. It is important, therefore, that the architect of today consider the advantage of the cardboard model as a means of representation.

In the first place the model is an exact replica of the building to be built, though at a smaller scale. It is as if the building were completed and suddenly dwarfed, yet the model is real in every aspect. The model is truth telling, and not dependent upon cleverness of line and color to give an effect of reality. It is an honest and obvious representation of the building as it is actually to be built. It is concrete, is in three dimensions, and can be viewed from all angles and distances rather than from one or two carefully selected places that will show the design to best advantage, as is the case with the perspective sketch. The reduction in scale, practically the same in both cases, is as easily read off from the model as from the perspective. Then, too, at times even the perspective sketches are hard for the client to understand. Furthermore, it is too often the case that sketches of poor designs are "faked," carefully rendered with a fairyland of entourage to attract the client's eye, in which case of course the transaction is that of selling a picture rather than a building. The first and greatest advantage to the client, then, is that he may see exactly what he is getting. Form, color, relation, proportion, composition, and harmony—all are truthfully portrayed.

Advantages of Models to Architect.—The use of models also offers some advantages to the architect. A model gives the architect an opportunity to study the design by assembling and changing parts. Defects in design that fail to show up in drawings or perspectives stand out glaringly in a

model. If models were used in the study of the design of a building, such incongruities of design that might otherwise creep in could be cast out before the building were completed or under construction.

The use of the model is the ideal method of securing harmony between parts of a design. For instance, dormers may be made to size, moved about on the roof until their best location is found, and then secured in place. Roofs can be tried on as one would try on hats in a shop. Thus the model offers the best chance to study the design of a structure in its elementary components, and their relation to the completed project. Models give the architect a chance to create first, and then market. Furthermore, by the use of models an architect may effectually demonstrate his talking points.

How much easier it is to lift the roof off a model and point out to the client the convenient arrangement of rooms, or some other desirable feature; or perhaps to remove the side wall of a model that the client may see the inside of the proposed building—how much easier it is to perform these slight operations than to spend time in explaining to the client the meaning of the floor plan, then that of the elevation, and perhaps an interior perspective, and in trying to fit them together in such a manner that he may get a picture of the completed building. The model is indeed a time saver for the architect.

Cost of Models.—Nor must we forget the cost. According to the standards of practice adopted by the American Institute of Architects, the architect gets for his services 6 per cent of the cost of the building, and of this amount one-fifth is for preliminary studies. Let us see just what this means. Since the working drawings, specifications, and superintendence are almost entirely matters of engineering, it is in the preliminary studies that architecture has an opportunity to express itself as an art. A little over 1 per cent is actually spent on architecture. Yet the thing that occupies the attention of the buyer of architectural services is the 6 per cent. The result is almost inevitable. Some unscrupulous architect gains, and the community in which the architectural misfit is erected, suffers. A colored cardboard model whose purpose is to show the general design, composition, proportion, mass central feature, color, etc., appeals to the senses of the client, and tends to get his mind away from the 6 per cent. And who would not pay more if they knew exactly what they were buying, that is, if they could see what they were going to get, rather than pay less, and run the risk of getting what the plans called for, and yet not what they expected, or wanted.

Then too, the actual cost of the models is not very great. Mr. LeRoy Grumbine, who has had much experience in the construction of cardboard models, states in the American Architect that one model may be constructed for what two or three perspective sketches would cost.

Use of Models in Competition.—To the men of the profession of architecture who really have the welfare of the profession at heart, the model has another significant use—in competitions. It is the one and only means by which the best design submitted in a competition may be chosen entirely upon its own merits. And when, in the course of human events we reach the stage where such a selection is made—then America will begin to have all that is really good in architecture.

Since the public, when educated to appreciate and demand models, will require a colored model as a part of the preliminary sketches, it is pertinent that the architect learn the easiest and most economical ways of constructing models, which at the same time will give the best results.

Models may be used to represent buildings, formal gardens, or landscapes. The architect is primarily interested in the first group. The second group may be used either by the architect or the landscape architect, and the last is used only by the landscape architect, unless of course the nature of the project calls for the services of the architect. However the last two groups have more to do with the entourage, shrubberies paths, walks, terraces, lakes, and streams, and we shall not be concerned with them in this paper.

Types of Models.—There are three main types of models of buildings each of different construction. There is the more common type constructed by extensive developed surfaces assembled in a permanent way. This type is used where the most interest is centered upon the external appear-

ance of the buildings, for instance where several units are to be combined, or where some new buildings are shown in place with others already constructed, to give an idea as to how well they fit in with the surrounding buildings. Then there is the type which is constructed so that the roof may be taken off, or the walls removed, in order to get a view of the interior. This type is particularly adaptable to the study of churches and theaters or similar buildings in which the seating is an important element. Then there is the type known as "latero-sectional" models, developed by a Boston firm, and unique in their origin, which was at a court proceeding. In order to show the damage done to a proposed expansion of a hotel building by a subway tunnel cutting across the property, a model was submitted as court evidence. The part cut away by the tunnel was separate, and could be removed. The feature of this type is in the construction by sections. The stories are all separate pieces, placed one upon another, and held in place by small dowels. The body of each section is a plank, carefully planed to the desired thickness, with the cardboard exterior pasted on. The plan of the floor is worked out on each section, and the plan of the ceiling of the next lower floor is drawn on the under side of the same piece. The advantage of this type is obvious. Besides seeing the building as it will be, the client may obtain a "look-in" at any floor.

Methods of Constructing Models.—There are many methods of constructing models, and since each architect sooner or later develops a particular technique and style of execution, we shall not try, in this brief paper, to even summarize the methods of construction. However, in passing, it is of interest to notice some of the common practices, and some of the different materials.

The architect must choose the proper scale; one that will leave out no details of importance, and one that will cause no excess in the work of execution. The scale of ⅛ in. to the foot is common, though Mr. Harvey W. Corbett, of the firm of Helmle & Corbett of New York finds that even small scales are advisable. In the smaller scales many of the projections that would otherwise have to be constructed or built up are merely indicated by rendering.

Though most any effect may be obtained by rendering, there are some papers that are especially adapted to the representation of type surfaces. Thus, corrugated cardboard with a little alteration makes good tile roofing. Certain tinted cardboards are ideal as slate roofings. Ordinary gray cardboard with the courses indicated gives a good effect of rough stone work. Shingles are represented by roughing the cardboard vertically with sandpaper and scoring horizontally.

When coloring the parts, the architect has to consider the fact that light has scale; that atmosphere and reflection do not miniature themselves to suit the model. Generally the color scheme should be keyed lighter in order that the model in a room will truthfully represent the completed building when viewed in normal sunlight.

After all the parts have been completed and assembled, the model is ready for mounting. If the grounds surrounding the building are very uneven and rolling, then the mount is made up of a grid similar to the sections of an egg case, with the sections cut to the contour of the land. Over the whole grid a paper upon which the roadways, walks, and pathways may be indicated, is mounted. The finer effects are obtained by the use of paper pulp. Life is added to the setting by the judicious placing of trains, automobiles, street cars, and pedestrians about the grounds. Trees and shrubbery add to the forceful presentation of a mounted model. These are made by dyeing bits of sponge and mounting them upon wires.

Photographing the Model.—And, finally, when a model is completed it is often necessary to preserve a record of the model, if not the model itself. If the model is not preserved, then photographs of the models may be taken and filed. And in the use of composite photographs the architect has a means of showing the client how his completed building will look upon its building site. To do this, a photograph of the proposed site is taken, and the distance from the site to the exact position of the camera noted. At a corresponding distance from the model (measured to scale) another picture is taken. If the dis-

tance from the model is too small for the ordinary camera lens to function properly, then a pin-hole camera may be substituted. Now if these two photographs be combined, the resulting composite photograph is an exact reproduction of the building in place.

Application of Models in Engineering Lines.—Though the discusion has thus far been confined to the use of models in architectural representation, one can easily see the application of the use of models to any engineering line. The engineering student, in his drafting room, learns to picture an object in straight orthographic projection, or possibly in isometric or perspective drawings. Since he is constantly working in this style of representation, he is accustomed to visualizing objects in this manner. And everyone recognizes the value of this type of representation for office and shop work. But when one stops to think how all thees drawings appear to one outside the profession, to one uninitiated in the art of reading scale drawings, he can appreciate the position of those who wonder what it is all about. It is plain that another means of representation is needed.

Of course when the project is of such a nature that it requires the services of an architect, then it is the place of the architect to furnish those models. But at times there are projects in which the predominating feature is some engineering feat, and not an architectural accomplishment. It is in these projects that the engineer may show his skill and originality in constructing models. Just as the architect may study his design from the model, so may the engineer study his larger problems from the model.

Building Construction to Be Taught at Yale.—A course in building construction is being offered at Yale as a development of the Civil Engineering course. The move is being made upon the theory that building construction is looked upon more as a profession in itself than subordinate to architecture. The course is made possible by gifts from the trustees of the Louis J. and Mary E. Horowitz Foundation.

Standard Abbreviations of of Terms Used in Lumber Industry.

The Forest Products Laboratory of the U. S. Forest Service recommends as standard the following abbreviations of terms used by the lumber industry. Most of the forms given correspond to those already in common use. In a few cases new abbreviations have been suggested where the old forms overlapped or were misleading.

AD—Air-dried.
a. l.—All lengths.
av.—Average.
av. w.—Average width.
av. l.—Average length.
a. w.—All widths.
B1S—Beaded one side.
B2S—Beaded two sides.
BBS—Box bark strips.
bd.—Board.
bd. ft.—Board foot.
bdl.—Bundle.
bdl. bk. s.—Bundle bark strips.
Bev.—Bevelled.
B/L—Bill of lading.
b. m.—Board (foot) measure.
Btr.—Better. Also Bet.
c. i. f.—Cost, insurance and freight.
c. i. f. e.—Cost, insurance, freight and exchange.
Clg.—Ceiling. Also C/G and Ceil.
Clr.—Clear. Also Cl.
Com.—Common.
Coop.—Cooperage (stock).
CM—Center matched; i. e., the tongue and groove joints are worked along the center of the edges of the piece.
Csg.—Casing. Also C/S.
Ctg.—Crating.
cu. ft.—Cubic foot.
Cust.—Custom (sawed).
D&CM—Dressed (one or two sides) and center matched.
D&H—Dressed and headed; i. e., dressed one or two sides and worked to tongue and groove joints on both the edges and the ends.
D&M—Dressed and matched; i. e., dressed one or two sides and tongued and grooved on the edges. The match may be center or standard.
D&SM—Dressed (one or two sides), standard matched.
D2S&CM—Dressed two sides, center matched.
D2S&M—Dressed two sides and (center or standard) matched.
D2S&SM—Dressed two sides and standard matched.
Dim.—Dimension.
D.S.—Drop siding. Also D/S. Synonymous with cove siding (C. S.), novelty siding (N. S. and Nov. Sdg.), and German siding (G. S.).
E—Edge. Also Ed. and Edg.
E&CB1S—Edge and center bead one side; i. e., surfaced one or two sides and with a longitudinal edge and center bead on a surfaced face. Also B&CB1S.
E&CB2S—Edge and center bead two sides; i. e., all four sides surfaced and with a longitudinal edge and center bead on the two faces. Also B&CB2S.
ECM—Ends center matched.
E&CV1S—Edge and center V one side. Also V&CV1S.

E&CV2S—Edge and center V two sides. Also V&CV2S.

EM—End matched—either center or standard.

ESM—Ends standard matched.

exp.—Export (lumber or timber).

f. bk.—Flat back.

FAS—Firsts and Seconds—a combined grade of the two upper grades of hardwoods.

f. a. s.—Vessel (named port). Free along side vessel at a named port.

Fcty.—Factory (lumber). Also Fact.

F. G.—Flat grain. Synonymous with slash grain (S. G.) and plain sawed (P. S.).

Flg.—Flooring. Also F/G.

f. o. b. (named point)—Free on board at a named shipping point.

f. o. k.—Free of knots.

f. o. w.—First open water.

Frm.—Framing.

ft.—Foot or feet.

ft. b. m.—Feet board measure.

ft. s. m.—Feet surface measure.

Furn.—Furniture (stock).

G. R.—Grooved roofing.

h. bk.—Hollow back.

Hdl.—Handle (stock).

hdwd.—Hardwood.

Hrt.—Heart.

Hrtwd.—Heartwood.

1s&2s—Ones and two—a combined grade of the hardwood grades of Firsts and Seconds.

Impl.—Implement (stock).

in.—Inch or inches. Also two accent marks (").

KD—Kiln-dried. Also K/D.

k. d.—Knocked down.

lbr.—Lumber.

l. c. l.—Less carload lots.

lgth.—Length.

lgr.—Longer.

lin. ft.—Lineal foot; i. e., 12 inches.

Lng.—Lining.

LR—Log run.

LR, MCO.—Log run, mill culls out.

Lth.—Lath.

M—Thousand.

M b. m.—Thousand (feet) board measure.

MCO—Mill culls out.

Merch.—Merchantable.

m. l.—Mixed lengths.

Mldg.—Molding.

MR—Mill run.

M s. m.—Thousand (feet) surface measure.

m. w.—Mixed widths.

No.—Number.

Ord.—Order.

P.—Planed—used synonymously with dressed and surfaced as P2S&M, meaning planed two sides and matched.

Pat.—Pattern.

Pky.—Pecky.

Pn.—Partition. Also Part'n.

Prod.—Production. Also Prod'n.

Qtd.—Quartered — when referring to hardwoods. Also see V. G.

rdm.—Random.

Rfg.—Roofing.

res.—Resawed.

rip.—Ripped.

Rfrs.—Roofers.

r. l.—Random lengths.

rnd.—Round. Also rd.

R. Sdg.—Rustic siding.

r. w.—Random widths.

S&E—Surfaced one side and edge.

S1E—Surfaced one edge.

S2E—Surfaced two edges.

S1S—Surfaced one side.

S2S—Surfaced two sides.

S1S1E—Surfaced one side and one edge.

S2S1E—Surfaced two sides and one edge.

S1S2E—Surfaced one side and two edges.

S4S—Surfaced four sides.

S4SCS—Surfaced four sides with a calking seam on each edge.

S&CM—Surfaced (one or two sides) and center matched.

S&M—Surfaced and matched; i. e., surfaced one or two sides and tongued and grooved on the edges. The match may be center or standard.

S&SM—Surfaced (one or two sides) and standard matched.

S2S&CM—Surfaced two sides and center matched.

S2S&M—Surfaced two sides and (center or standard) matched.

S2S&SM—Surfaced two sides and standard matched.

Sap.—Sapwood.

SB—Standard bead.

Sd.—Seasoned.

Sdg.—Siding. Also Sidg. and S/G.

Sel.—Select.

S. E. Sdg.—Square-edge siding.

s. f.—Surface foot; i. e., an area of one square foot.

Sftwd.—Softwood.

Sh. D.—Shipping dry.

Ship.—Shipment or shipments.

Shlp.—Shiplap. Also S-L and S/L.

s. m.—Surface measure. Synonymous with face measure (f. m.).

SM—Standard matched.

smkd.—Smoked (dried).

smk. stnd.—Smoke strained.

s. n. d.—Sap no defect.

snd.—Sound.

sq.—Square.

Sq. E&S—Square edged and sound.

Sqrs.—Squares.

Std.—Standard.

stnd.—Stained.

stk.—Stock.

Stp.—Stepping.

S. W.—Sound wormy.

T&G—Tongued and grooved.

TB&S—Top, bottom and sides.

Tbrs.—Timbers.

V1S—V one side; i. e., a longitudinal V-shaped groove on one face of a piece of lumber.

V2S—V two sides; i. e., a longitudinal V-shaped groove on two faces of a piece of lumber.

V. G. — Vertical grain. Synonymous with edge grain (E. G.), comb grain (C. G.), quarter-sawed (Q. S.), quartered (Qtd.), and rift-sawed (R. S.).

w. a. l.—Wider, all lengths.

Wth.—Width.

wdr.—Wider.

Wgn.—Wagon (stock).

wt.—Weight.

Architecture and the Spirit of the Community

Paper Presented Before Washington State Chapter of American Institute of Architects

By CARL F. GOULD,
President Washington State Chapter, A. I. A.

The American Institute of Architects, composed, as it is, of local chapters distributed throughout the entire United States, has a cohesive strength and is of value to the various communities and to the country at large just to the extent that each individual is impelled by that apparently indefinable impulse to create in our physical necessities, orderliness and beauty. Just what is it that puts the spirit into the architect and keeps him at his work day by day when he knows from the beginning to the end of his profession that he cannot obtain what all the world seems most to desire—worldly increment.

To an outsider who may happen to be present at one of our conventions such subjects as building ordinance, competition codes, employment or labor, schedule of charges, etc., would appear to be those which are uppermost in our minds.

These subjects are always discussed with a fervor and intensity of feeling by cultured and intelligent men, while the very inner reasons for our existence are apparently ignored. This may be due to the fact that the intimate things of the spirit we never allow to appear in the foreground of our consciousness; it may be we cannot find words that adequately give our feelings expression. We hesitate, while the most obviously secondary things slip easily into words and inhibit an expression of our real feelings.

Beauty the Soul of the Profession.—We cannot easily describe the fervor of feeling of bringing into being something that the world wants—whether it is a shelter for a family or a place in which to worship or a bridge for our traffic to cross upon—but there is a fundamental impulse which when expressed and we see its accomplishment gives a sense of satisfaction. When, however, to these creations we add an element of what is recognized as beauty, the pleasure of creation is greatly intensified. This ingredient of beauty, which is the very soul of our profession, we seldom or ever allow ourselves to consider.

I remember so well some years ago at a convention held in Washington, D. C., an address by Lloyd Warren, who died recently, in which he said that the artist in the architect must be in command. I recall also an inspiring statement made at the close of our convention two years ago by Dr. Suzzallo, president of the University of Washington, that we, the architects, were the custodians of beauty, a thought which places an uplifting responsibility upon us and one which we should treasure. It must be just this desire of creation in terms of beauty that puts the spirit into our profession and makes it possible for us to endure its hardships and the frequent lack of public esteem.

Inherent Elements in a Building.—I am going to try to analyze for a moment a few of the ingredients of which this term "beauty" in architecture is composed. I realize my utter incapacity for doing this, and beg you not to grow impatient. I shall limit myself to the discussion of a few of the inherent elements in a building which are not usually considered factors in determining its beauty, I shall not discuss proportion or the charm and quality of detail, which we so often think of as the only medium of expressing architectural beauty.

These can be best illustrated by taking you for a moment upon a trip to a far country. The very wonder of the Egyptian pyramids draws us to them. We are lifted out of the monotony of our own life into the realm of the spirit of universal man in their presence. No people ever strove harder to divert more of their hard-earned economic wealth to make effective and give beauty of expression to their belief in the life of the soul than the Egyptians. In the presence of the sheer size of these pyramids an emotion is aroused just as were aroused the emotions of the Egyptians 5,000 years ago. Realize for a moment that their mass laid down upon, for instance, the 40-story Smith Building, would completely encompass it and rise many feet beyond its height.

It is by the very extent of the mass alone that we are impressed.

The wonder which is engendered by this external mass may also be engendered by internal space, such as the interior of St. Peter's at Rome, the Pennsylvania Station at New York, and to a less degree by the interior of the Forestry Building at the university. Sheer size is one of the means by which the architect can create an emotional appeal, and it must be taken into account as a factor or element of beauty. The Egyptians expressed the spirit of their race in terms of horizontality, the stability of line of their temples, of the unbroken silhouette against the sky, of the unpierced walls, of sturdy columns with their flat roofs and sombre interiors. Stability, endurance, finality, are the feelings we have in the presence of these big hypostyle halls. These were the architectural elements to which the Egyptians attached importance, and to them these were the essence of their life, and it is these appealing emotions of the ages which we travel many thousands of miles to obtain.

The Spirit of Mediaeval Architecture.—For a moment let us enter into the spirit of the mediaeval architectural expression, and we develop a series of entirely different emotions. The moment we set foot in the most marvelous of all buildings, a cathedral of the Gothic period, the eye does not travel horizontally as in Egypt, but follows up the attentuated clustered supports into the mysterious maze of pointed forms overhead. The whole seems not borne by earth, but something hung in the air. The weight of tradition is not upon us; a precedent plays no part. A vibrant atmosphere grips us. Imperfect in its incompleteness, maybe, but aspiring to infinity. Such is the emotional appeal that the great architects of the middle ages gave to the world a thousand years ago and to which we still respond.

The cool splendor of Greek architecture neither attempts to impress us by its sheer mass nor by its aspiring quality, but through the intellectual relationship of its parts and the exquisite refinement of all its elements, which can only be perceived and enjoyed by the highest type of mind; while beauty to the Roman was not primarily expressed in terms of refinement of parts, but by sumptuousness of detail and by a variety of forms, principally by the use of the arch and the vault.

These are all qualities which we usually do not consider as pertaining to beauty, but without which the monuments of the past could not have emotionalized the world down through the ages.

Until we can in our present forms of building attain to something which in its inherent mass expresses an intention which is a natural outcome of our present life and civilization, can we really hope to give to the world an architecture which will be of permament beauty. At the present time we are so overlaid with a confusion of impressions and emotions that we have apparently no dominating one which gives a direction to our thought and from which the architect can obtain positive inspiration. On the one hand we find a structure like the Woolworth Building, piercing the air with a vibrant vertical effect, apparently satisfying all the elements which make for beauty, an inspiration which one would think would be followed. A new office building, however, is constructed in its vicinity, notably the new telephone building, the most costly office building in the world, made up of a series of superimposed Greek marble temples, having no apparent intention of and totally contradicting its magnificent neighbor.

Lack of Coherent Relationship.—We have our court houses, post offices and our libraries expressing calm horizontality; we have our institutions of learning, expressing verticality; our city streets are made up of contradicting elements, and beauty exists only in isolated buildings here and there, not in the coherent relationship of a building to its neighbor. An eminent Frenchman in a recent interview states that "it is disconcerting to turn from manifestations of American architectural genius to the unsightly streets nearby, in the building of which all consideration apart from the strictly utilitarian would seem to have been banished. Houses big and small, handsome and hideous, pretentious and insignificant, ornamental and sordid, huddled sideby side in jarring promiscuity, mute testimony of the stern material necessities and the preoccupations of the past. One is tempted to liken New York architecturally (he continues) to a garden overgrown with gigantic weeds, cleared in parts to make room for fair, well-trimmed avenues. Yet on all

sides I see such strong evidence of a swiftly developing national artistic temperament that I am convinced the present blemishes will in due course be swept away."

The Selection of the Type.—The selection of the type of architecture with which we express a building for our client is seldom if ever based on a deep conviction, rarely if ever does the client bring any intelligent reason to bear on why he wants one type of building rather than another; the only demand he makes is that it be entirely dissimilar to any building in the vicinity. How, then, is it possible for us to obtain beauty in the total effect of our buildings if we cannot agree on any singleness of purpose. Is it not true that in this Northwest corner of the United States, with Canada touching us on the north, here is a certain individuality apparent which might be translated and expressed in architectural terms? Are we not as a group quite different in feeling and sentiment from the people of California? Is it not the habit of mind of our people different from that in the south? Are not the variations in our climatic conditions a partial cause for this difference? What little historic background we have is not the same. Do not our conditions more closely approximate those of Northern Europe, whereas California approximates the conditions of the Mediterranean basin? If this is true, the horizontality, the calmness, and the massive walls belong to California, while the vibrant verticality, the small extent of wall with large window area, are characteristic of us. Therefore, it seems to me that if our clients do not help to bring unity out of chaos, is it not our duty to attempt to do so by conscious agreement? However beautiful an individual building may be, if it does contain the fundamental ele- of the community in which it is placed it does contain the fnudamental elements of beauty. Even if the most beautiful building in the world, such as the Taj Mahal, were transported to the British Isles, it would be an exotic thing, just as an objet d'art would be in a museum case.

It seems to me that we architects should strive to discover or evolve or transport an architectural type which most nearly seems to fit our conditions and accept it as a basic point of departure, and each one of us as best we can evolve and apply such a type, until either we or those who come after us are able to wield it into a form which perfectly expresses our community, as did the temples of the Egyptians and the churches of France each express the spirit of their communities.

Changes in Retail Cost of Food

The U. S. Department of Labor, through the Bureau of Labor Statistics, has completed the compilations showing changes in the retail cost of food in 23 of the 51 cities included in the Bureau's report.

During the month from May 15, 1923, to June 15, 1923, 18 of the 23 cities showed increases as follows: Newark and Washington, D. C., 3 per cent; Cleveland, Detroit, and Norfolk, 2 per cent; Atlanta, Bridgeport, Butte, Denver, Los Angeles, New Haven, New York, Portland, Ore., and Richmond, 1 per cent; and Birmingham, Charleston, Manchester, and Scranton, less than five-tenths of 1 per cent. There was a decrease in the following 5 cities: Boston, Portland, Maine, St. Louis, and St. Paul, 1 per cent, and Philadelphia, less than five-tenths of 1 per cent.

For the year period, June 15, 1922, to June 15, 1923, 22 of the 23 cities showed increases. Bridgeport, 7 per cent; Cleveland, Manchester, Newark, and New Haven, 6 per cent; Boston, 5 per cent; Birmingham, Los Angeles and Portland, Maine, 4 per cent; Butte, Denver, Detroit, New York, Norfolk, Philadelphia, and Washington, D. C., 3 per cent; Portland, Ore., and Scranton, 2 per cent; Charleston and St. Louis, 1 per cent; and Atlanta and Richmond less than five-tenths of 1 per cent. In St. Paul there was a decrease of 1 per cent.

As compared with the average cost in the year 1913, the retail cost of food on June 15, 1923, was 56 per cent higher in Richmond; 54 per cent in Washington, D. C.; 51 per cent in Detroit and New York; 49 per cent in Birmingham, Philadelphia, and Scranton; 48 per cent in Charleston; 46 per cent in Boston, Cleveland, and Manchester; 45 per cent in Newark and New Haven; 43 per cent in St. Louis; 42 per cent in Atlanta; 39 per cent in Los Angeles; 35 per cent in Denver; and 31 per cent in Portland, Ore. Prices were not obtained from Bridgeport, Butte, Norfolk, Portland, Maine, and St. Paul., in 1913, hence no comparison for the 10-year period can be given for these cities.

The Professional Status of Engineering

Address Before Engineers' Club of Philadelphia

By JOHN LYLE HARRINGTON
Consulting Engineer; President American Society of Mechanical Engineers.

I am disposed to talk on a subject that has been in all our minds for a great many years—and we have done very little about it. I don't know how we are going to do very much about it, except by individual effort here and there. But the engineering profession has occupied throughout history a very singular place. The history of the early centuries of the human race has been devoted almost entirely to the doings of the King; then to the doings of the Warrior, and a little later to the professional man of a kind. In the time of Hammurabi they wrote about the doctor, for the King laid down laws for the punishment of the doctor if he failed to perform the duties of his office loyally and well. In the days of their power the Greeks gave especial honor to the philosopher and the poet and the sculptor. The priest has been well known throughout history. But the engineer has been back of the scene—furnishing the fundamental knowledge upon which civilization has been developed all the time, but has not been known at all. He has been content to occupy a singularly secluded sort of place. So far as I recall there was no mention of the work of Leonardo de Vinci as an engineer until comparatively recent times. He was known as an zation of engineers there were only two kinds, the civil and the military. The civils very shortly were unable to agree among themselves, and they split into one class and then another, until today we have literally hundreds of engineering societies. Someone in the Mechanical Society has taken the trouble to make a list of the different societies of engineers, and he found more than thirty organizations in the United States devoting themselves simply to mechanical lines of work. Engineers cannot get along with each other in their professional work, and they certainly do not get along with each other in their business relations, for today the ethics of the profession of engineering is very much lower than the ethics of the medical profession or of the law.

Engineers contest with engineers in public and in private in a way that the members of other professions do not do. Sometimes I think they show each other very much less ethical consideration than do the men in ordinary business.

Must Acquire Professional Consciousness.—In order to acquire a professional consciousness which will give unity as a profession, which will enable us to present a united front to the world and present our claims for consideration, we must first realize the position in which we now stand. In our public affairs today the engineer furnishes the knowledge while the lawyer or the public official does the talking; and the honor and the consideration of the public go to the official or the lawyer who does the talking, even though the engineer furnishes the energy and knowledge for accomplishment.

Our governments, particularly of our cities, depend upon engineers to carry out their projects; but the governments themselves are not operated by engineers, they are not operated by the men who know best how to operate them; that is left to the men who make more or less of a profession of politics—while the engineers behind the scenes furnish the special knowledge and ability necessary to conduct a modern city.

We have come to spend a large portion of our income from taxation on public works and the operation of public works. Today the direct taxation in the United States is approximately $80 per capita, a very large proportion of the total value of the nation's production; but the engineer, who directs the expenditure of the great bulk of this money, has a very small part in the actual control, a very small part in saying how it shall be spent—because he does not work to get such control, because he cannot get on with his fellows, cannot agree with his neighbor; and, therefore, he cannot secure the part in this work that really belongs to him.

I don't know how we are going to overcome the difficulty. We are today, of course, educating our engineers as never before (something like 5,000 men a year graduating from

our universities), giving them as high ideals as the faculty can give them—and that says a great deal for the men who go out from the engineering schools, but it does not give them the ability to work with others, they do not go out of school with any well-defined degree of professional consciousness.

Older Engineer Responsible for Views of Younger Men.—We older engineers are in some measure responsible for the fact that the young men do not gain a proper view of their profession. It is too commonly the practice of the older men to tell the recent graduate he is a "cub" and doesn't know anything yet about the profession, is a nuisance to the place, has to be taught, and in a mental sense kick him and cuff him and lead him to believe he is of a lower order and has some years to go before he achieves a position in the profession—instead of taking him in immediately on graduation and giving him something of the professional viewpoint, something of professional consciousness, something of a willingness to stand up with his fellows and esteem his profession highly, he is given a rather low viewpoint.

And you will find among the younger men in the country a good deal of fretting against that position, and justly so. In the railroads and other large corporations, particularly, it is true the young men have been given a place far beneath that which belongs to professional men; and we older men owe to the young men an education in their professional status, an education in the way of a viewpoint regarding the high character of the profession they are entering.

Not Enough Attention Given to Ethical Side.—In our national societies we are not giving enough attention to the ethical and professional side of our work; we are dealing primarily with the scientific side, we are dealing somewhat with the business side, with economics, to some extent with accountancy. We are aiding the young men to a broader understanding of business. Older engineers are taking an increasingly higher place in business, and there is an astonishing number of engineers who have become presidents of railroads, of manufacturing companies, even of banking corporations, and in various works of that kind. I have acquaintances in New York who are devoting themselves entirely to the reshaping of the finances of corporations in difficulty, using their engineering knowledge as a basis for their account and financial ideas. They are doing splendid work along that line.

We find engineers undertaking a good many lines of work that heretofore were not considered engineering work at all, but which are based on engineering work, and which are fundamentally dependent upon the engineer. But as a profession we are not taking cognizance of the fact that the individual engineer is doing that kind of work; we are not showing the younger graduates that that is a part of the engineering field, and we are not fitting them in any way, in our national societies, to deal with the business problems built on engineering knowledge. I think it is high time we should give a broader understanding and training to the men who graduate from our engineering schools.

Engineers Have Public Service to Perform.—We have for some years been trying to establish the fact engineers have a public service to perform, that they owe the public a certain amount of professional service for which they are not paid—a gratuitous service such as the lawyer renders when he goes into politics and takes a vigorous part in shaping the policies of our country, and such as the doctor renders when he serves in public health movements.

The engineer has done astonishingly little in the way of performing public service. We must take the onus of giving public service—for there is an onus attached to it: the moment you perform public service, gratuitously or otherwise, you are subject to attack by those politically inclined and opposed. But we have to pay the price of our "place in the sun" and take a part in public work, regardless of the mud that is slung, regardless of the broadsides of calumny that sometimes come to the public official.

Must Take Greater Part in Public Service.—We must take our part in public affairs in a much broader way, if we are to convince the world that we are truly professional men. We are still looked on as a species of artisan. Coming from California the other day I met a new kind of engineer, an "Exhibition Engineer." He told me he had been sent over to Germany particularly to study how the Hagenbeck people erected their tents, and that he had then been brought

back and given charge of handling the tents and arranging the stalls in the food shows given by The National Cash Register Company and the Toledo Scale Company. He was an "Exhibiting Engineer."

Recently one of my friends, a graduate of "Tech," explained he had been down South looking at some coal properties, and the man who drove him around in the Ford was a rather peculiar individual, who wore a long beard, didn't look particularly intelligent, and was generally of the backwoods type. But he told my friend he was an engineer. My friend asked him how he became an engineer, and this was his story: Some time ago he went to the Pacific Coast and got a job as dishwasher in a construction camp. He afterward became assistant cook, and then cook. Still later they put him to driving a team, and he became a teamster. After he had been there quite a while he was put to firing the donkey engine, and in the course of time was put in charge of the engine. He said, "Yes, sir, I ran the engine, and from that time I have been a Civil Engineer."

I confess the world looks upon us with just about that degree of understanding. It is astonishing at times how little the work of the engineer is understood by the public, how often it is confused—and all because we have not agreed among ourselves as to what our profession is. The National Societies have split off into their own particular lines of work, because each society in turn has been unwilling to give scope to the individual groups who wanted scope in that particular line. The Engineering Institute of Canada has been able to keep the bulk of the engineers of that country together by dint of a very great effort, but there are divisions even there; and I suppose we must expect divisions, but we should, in our separate organizations, be able to work together in harmony when it comes to matters of public interest and to matters of general professional interest. But we find that difficult to do, because we are civil, mechanical, electrical, refrigerating or some other kind of engineer —I don't know how many there are these days—and do our work without regard to our fellows.

Need for Collaboration in Matters of General Nature.—It is high time that we should think very seriously of collaborating in all matters of a general nature. We have, as engineers, looked with great interest on your efforts here to develop a World's Engineering Congress in connection with the World's Fair. We had a discussion at New York recently regarding the scope the Congress should take, and I believe there were as many opinions as men present. That is commonly the case in engineering matters—that the opinions vary very greatly, and each man insists his prevail. How it will "wash out" I don't know; but there is an opportunity, if the Congress is held, for the engineers to show a united effort, not only to this country, but to the world, and to adopt a professional attitude; and I hope in the course of three or four years—possibly in that convention—we can develop a united professional position, and show the world how we think and what we do. And I hope, in that case, we will deal with the matter so very broadly that the world will understand that the engineer's function is not to make drawings, not to wear high-topped boots and broad-brimmed hats and run lines with instruments in the field, but that he is a scientific business man, that he is behind all the development in this country, the development that has only just begun, and that is dependent to a large and increasing extent upon the engineer.

The banker and the business man each has his part to perform, but fundamentally it is a secondary part; the initial fight, the initial development, must rest upon the engineer; and I very much hope we can get together and have our country as a whole know us, have our cities and our states and the United States know us as a unit, as a profession, and appreciate the part we play.

We need to undertake a great deal more of governmental work. When the road development came it was expected the work would be very largely in the hands of the engineers, but we are backsliding. Two of our states have recently kicked the engineer out and put the politician in; and the engineer sits quiet and lets it go. Unless we wake up and act as a unit in our professional matters we have no real reason to object to having somebody else do our rightful work, and do it badly. That will be the result if we default in our responsibility.

I don't know how we are going to arouse this professional consciousness, but until we do arouse it we are going to occupy a less desirable place in the affairs of the world, and of our own country in particular, than we deserve.

Contract Between Architect and Owner

Form of Agreement Adopted by the Illinois Society of Architects

The following articles of agreement between architect and owner have been adopted by the Illinois Society of Architects, and published in the Monthly Bulletin of the Society, from which it is reprinted below.

Articles of agreement between architect and owner:

THIS AGREEMENT made the..... ..... in the year One Thousand Nine Hundred and ....., by and between ....., Architect located for the practice of his profession at..... ..... Street, in the City of ....., County of ..... and State of ...., doing business at ....., in the City of ....., County of ...., and State of ....., hereinafter called the owner.

Witnesseth: That the Architect and the Owner for the consideration hereinafter named agree as follows:

Article I. The Architect agrees to render full and complete professional services, including the furnishing of Preliminary Studies, General Drawings, Specifications, Scale and Full-Sized Details and General Supervision of the Work, for a proposed ..... Building, to be erected on lots owned by the said Owner, described as

Article II. The Architect and Owner agree that it is the professional service of the Architect which is to be furnished hereunder and that the instruments of service such as drawings and specifications are merely incident thereto and as such remain the property of the Architect; that the items of professional service are comprehended and proportioned to the complete services as hereinafter stated, namely:

(a) Preliminary Studies, amounting to Two-Tenths of the complete professional services, consisting of the necessary conferences, inspections, studies and sketches modified and remodified to determine the client's problem and illustrate a satisfactory general solution of same, both as to plan and elevation. Illustrative sketches for this purpose need not be to accurate scale, but should be approximately correct as to general dimensions and proportion.

(b) General Drawings, amounting to Three-Tenths of the complete professional services, consisting of figured scale plans of the various stories, elevations of all the fronts, such general vertical sections as may be necessary to elucidate the design, and such details, drawn to still larger scale, as, with the assistance of printed notes, and of the accompanying specifications, may make the whole scheme clearly evident to the mind of the competent builder and give him a full and complete comprehension of all the structural conditions as they affect the vital questions of quality and quantity of materials, of character of workmanship, and of cost.

(c) Specifications, amounting to One-Tenth of the complete professional services, consisting of a supplementary statement in words, or at least all those items of information regarding the proposed building which are not set forth in the drawings.

(d) Detail Drawings, amounting to One-Tenth of the complete professional services, consisting of all the necessary supplementary drawings required for the use of builders, to enable them to provide and shape their material that it may be adjusted to its proper place of function in the building with the least delay and the smallest chance for errors and misfits. If not prepared until after the contract for the building is let they must not impose on the contractor any labor or material which is not called for by the spirit and intent of the "General Drawings and Specifications," except with the consent and approval of both the owner and the contractor.

(e) General Supervision of the Work, amounting to Three-Tenths of the complete professional services, consisting of such inspection by the architect or his deputy, of work in studios and shops or at the building or other work in process of erection, completion or alteration, as he finds necessary to ascertain whether it is being executed in general conformity with his drawings, specifications or directions. In acting in this capacity his authority and status will be as defined in the "General Conditions of the Contract" of the "Illinois Building Contract Documents," which Illinois Building Contracts Documents are by reference made an express part of the work which does not conform with the spirit and intent of plans and specifications and order its removal and

reconstruction. He has authority to act in emergencies that may arise in the course of construction, to order necessary changes and to define the meaning and intent of the drawings and specifications. He is not required to give continuous personal superintendence, but should the Owner require this service, the Architect will employ a clerk-of-works or inspector to render such assistance under his direction, at the Owner's expense.

Article III. Subject to additions and deductions as provided in Article V of this Agreement, the Owner agress to pay the Architect for the performance of the contract, a sum equal to ..... per cent reckoned on a reasonable estimated total cost of executing the work herein required, to be designed, delineated, specified and supervised in construction by the Architect. Proportionate monthly payments shall be made by the Owner to the Architect in current funds, on or before the 10th day of each month according to the proportionate amount of the various items of hereinbefore defined service which have been completed by the Architect before the 1st day of that month.

Note: Total cost, wherever herein used as base for determining the ultimate fee due the Architect, shall be interpreted as what would be the reasonable cost of all materials and labor necessary to complete the work required to be designed plus contractor's profit and expenses, as such cost would be if all materials were new and all labor fully paid at market prices current when the work was ordered.

The Architect and Owner agree that the question of cost of executing designs for building is controlled by at least three factors:—(1) Fluctuating market conditions of labor and material which are beyond the control of either the Owner, the Contractor or the Architect. (2) Quantity and elaboration of material and labor which is entirely within the control of the Owner with the advice of his Architect. (3) Purchasing skill which is largely in the hands of the Architect. It is therefore mutually agreed that it shall be the duty of the Owner to choose between fixing limits on the character of design and quantity of materials or on ultimate cost, since at any time these two factors might be made incompatible by changing market conditions, or unforeseeable practical difficulties, and if the Owner elects to fix an absolute limit on ultimate cost, the Architect shall always be at liberty to make such alteration in design, specification and size, or any of them, as shall make it possible to bring the cost within the restrictions imposed by the Owner prescribing ultimate cost.

Article IV. The Architect and the Owner agree that the Illinois Building Contract Documents shall be used for the General Conditions to contracts between the Owner and Contractors, and the status of the Architect and relation between the Owner, Contractors and the Architect shall be as hereinafter especially enumerated, to-wit:

(a) In the supervision of the work, if by any contract, the Architect is made the interpreter of the drawings and specifications forming a part of any contract between the Owner and any Contractor; as such, it is his duty to define their true intent and meaning without fear or favor. He is to act in this capacity as an expert untrammeled arbitrator licensed so as to act, by the people of the State of Illinois. In so acting, he is not the agent of the Owner, and while acting in that capacity the Owner shall have no right to command his acts or decisions or in any way threaten or intimidate him in the honest discharge of his duty as an arbitrator.

(b) In cases of emergency only, the Architect has authority as a public officer to order extra work or materials, in order to safeguard human life or property.

(c) The Architect in his advisory capacity will not recommend by specifications or otherwise, any materials nor any contracting companies in which he has a financial interest, without fully informing the Owner of his connection or interest in same and obtaining owner's consent so to do. In all such cases he shall be deemed incompetent to act as arbitrator on questions between the Owner and the said Contractor, in any matters which may be disputed between them.

(d) Since by the terms and conditions of this agreement it is made the duty of the Architect to advise the Owner as to design, construction and methods of procedure, the Architect, during the preparation or preliminary studies, general drawings, specifications and details, shall not be considered as being guilty of insubordination or failure to carry out the instructions of the Owner if he submits design for approval or makes recommendations contrary to the Owner's previously ex-

pressed instructions, for it is mutually understood between them that it is the duty of the Architect to give the Owner the full benefit of his skill and experience.

Article V. The Architect and Owner agree that the following items of professional service are in addition to the services required by this Agreement, and if required by the Owner or in the judgment of the Architect are necessary on account of unusual and peculiar complications of the work, are to be paid for as hereinafter stated, to-wit:

(a) The Owner is to pay for the service of any specialists which may be required for additional service on unusual problems in Heating, Ventilating, Mechanical, Structural, Electrical and Sanitary problems. Nothing in this clause, however, relieves the Architect from the requirement to carefully compute and prepare complete detail plans and specifications for these portions of the work, exercising technical skill and usual care in the preparation of same. The Owner is to pay for special chemical and mechanical tests and service.

(b) The Owner is to pay for all necessary traveling expenses other than between the Architect's office and the building site.

(c) If the Owner requires a special clerk-of-works or inspector, he is to be selected by the Architect and work under his, the Architect's, direction, but his salary is to be paid by the Owner in addition to regular fee for professional service.

(d) If, after a definite scheme has been approved, changes in drawings, specifications or other documents are required by the owner; or if the architect be put to extra labor or expense by the delinquency or insolvency of a contractor, the architect shall be paid for such additional services and expense.

(e) What are commonly known as "Shop-drawings" if necessary to the execution of the work are to be furnished by the contractor or otherwise and are not required to be furnished by the Architect.

Article VI. (Here fill in any additional conditions, which may be required.)

"The Architect and the Owner, for themselves, their heirs, successors, executors, administrators and assigns, hereby covenant and agree that they will fully perform each and every condition of the above-mentioned agreement.

"In Witness Whereof the parties have hereunto set their hands and seals the day and year first above written."

Architect (Seal).
Owner (Seal).

Specifications for Metal Lath Construction

Specifications for metal lath construction, the combined result of many months of investigation into the specifications of leading architects, inspection of actual construction in all parts af the country, research into scores of building codes, circulating questionnaires among contractors and composing the views of the competing manufacturers, have been issued. The specifications are written upon the basis of weight only. This is the method adopted at the public conference held by the U. S. Department of Commerce through its Bureau of Standards and used in the American Concrete Institute Stucco Report. Among other advantages to the architect, this system has reduced the 73 or more different styles, weights, gauges and combinations of lath, which the architect needed to be familiar with, to only 10 different weights distributed between expanded metal lath, flat rib lath and ⅜-in. rib lath. The specifications have been approved by the Associated Metal Lath Manufacturers and the American Specification Institute. The specifications cover the quality of materials and methods of application of all types of metal lath expanded from sheets used for the following constructions:

Wood stud and joist construction; back-plastered metal lath stucco construction; stucco on metal lath over sheathing; overcoating stucco on metal lath; metal stud partitions, solid or hollow (fireproof buildings); metal stud partitions, solid or hollow (non-fireproof buildings); wall furring; standing furring; attached ceilings, steel floor beams; attached ceilings under concrete (removable forms); attached to concrete ceilings (permanent forms); suspended ceilings; beams and cornices; columns and pilasters; corner and jamb reinforcement in block partition construction; metal lath in steel joist construction; alternate specifications for maximum economy.

Permanence of Timber Work in Dikes

An extensive investigation has been made recently in the First New York Engineer District to determine how far above the low water plane the permanence of timber work in the dike can be counted on. Some interesting results of the investigation are given by John D. Myton, Assistant U. S. Engineer, First New York District, in the current issue of The Military Engineer.

As is generally known, the Hudson River, although of ample depth for navigation for many miles above New York, was originally very shoal for about 30 miles below Troy. Its improvement was undertaken by the state as early as 1797, and by the United States in 1834. This was effected by the construction of longitudinal dikes and by dredging. In all,

Dike on West Shore of Coxsockie Island, Showing Hole in Rock Fill

31 miles of dike have been constructed, some of which date back to 1834. Many of the dikes consist of a double row of round piling, with square timber walings on the front and back, tied together with iron or timber ties, the dike being filled with rubble stone to, or above, the top of the piles. Most of the piles are local pine and the square timber is yellow pine.

The water in the river in the reach under improvement is fresh, but the level fluctuates with the tide during the low-water season. The average range of tide in the reach is 3.4 ft.

In the older dikes the timber work is carried to about high tide elevation. The upper part of this timber work, which is exposed to the weather for the greater part of the time, has decayed and the bolts and tie rods have become loosened. The deterioration is shown on the accompanying photographs, both of which are of dikes constructed in 1893 with the top of the timber work at about high tide level.

There is under contemplation an extensive program for the repair and reconstruction of the dikes, including the construction of superstructures to raise all dikes to a grade line equivalent to the 10-ft. freshet stage at

Dike on West Shore of Schermerhorn Island, Fill Washed Out

Albany. In designing the work under this program it was necessary to determine the height above the mean low-water plane at which the timber would not be affected by decay. An examination of some 200 piles in the oldest of the existing structures was made, generally by boring into the piles from the top or, if the tie rods or spikes prevented this, by boring into the sides of the piles through the heart. In these tests, it was found that the wood was sound to heights generally between one and two feet above mean low-water. In but very few cases had the decay of the piles as a whole extended below the elevation of one ft. above mean low-water.

Tests of Timber Work in Hudson River Dikes Troy to Albany

Age of Piles Yrs.	Elevation of top of pile above local M. L. W.-Ft.	Elevation below which wood was found to be sound Local M. L. W. Ft.
26	1.70	1.30
27	1.65	1.45
28	3.60	3.10
28	3.70	3.20
28	3.70	2.70
28	3.60	2.70
45	2.01	1.60
45	2.01	1.85
49	2.50	1.00
49	2.45	1.95
52	2.95	1.45
52	2.85	1.05
55	2.20	1.70
55	1.60	1.20

Corrosion of Iron in Concrete

Results of Some Swiss Investigations

In a report on the corrosion of iron in concrete Mr. Bruno Zschokke, of the Zurich Institute for Testing Materials, according to Concrete and Constructional Engineering, London, recommends the following precautions:

(1) The concrete should not be too meagre, but should contain the best percentage of cement so as to make it impermeable to air. Thus, the proportion of calcium hydrate, which prevents oxidation, is increased, and the concrete is also more impermeable to carbonic acid, which neutralises the lime.

(2) There must be no substances in the concrete such as locomotive cinders, often containing sulphur, which exert a chemical action on iron.

(3) The layer of concrete covering the iron should be of sufficient thickness properly to cover it, and should not crack under pressure or through shrinkage.

The report states:

The Gary Experiments.—It has been demonstrated by the experiments of Gary that a compact cement or concrete in sufficient thickness will protect iron against oxidation for a considerable length of time, provided that the cracks due to shrinkage do not reach the iron.

The experiments also demonstrated that a coating of red lead on the iron will prevent rust during five years. It must, however, be noted that the concrete employed in the experiments was not of the composition usually used in building construction, but was a mixture of 1 part of cement to 4 parts of sand, perfectly free from cracks.

The problem of the prevention of the formation of crecks in shrinkage has not yet been solved, and as they make their apeparance in rich concrete oftener than in meagre, the question arises as to whether oxidation cannot be more surely prevented by other methods than those specified.

It has yet to be ascertained whether the action of solutions of chromates cannot be profitably applied to protect iron in concrete. To elucidate this the point to be examined is whether the effect of these solutions when mixed with certain other saline solutions, or even solid substances, would not be more or less affected or even nullified. This is the case with alkaline sulphates, chlorides, and alkaline earth, e.g., sea salt, calcium chloride, magnesium chloride, Glauber salts, etc. Thus, when iron is exposed to the action of sea-water or salt marshes the use of chromates is out of the question.

Rust Prevention Systems.—The principal systems hitherto adopted to prevent rust consist in the production of a magnetic oxide film in coating the iron with another non-oxidable metal by galvanisation, electrolysis, spraying by the Schoop method, etc., ordinary varnishing, or coating with an oily substance.

The Zschokke method, however, consists in the utilization of the known property of some salts which makes iron passive when immersed in aqueous solutions concentrated to a degree exceeding a certain limit, usually very low. The most energetic of these salts comprise chromium salts, especially sodium bichromate and monochromate.

Experiments to Find Influence of Cement on Protective Chromates.—To ascertain the influence of cement on the protective chromates, especially in mixing, when the calcium hydrate is liberated, a small polished iron plate was dipped into a 0.5 per cent solution of potassium bichromate with 6 grammes of portland cement underneath. After a year the plate was covered with a pale grey film of calcium hydrate, without a trace of rust, a proof that the calcium hydrate disengaged by the cement had no action on the chromates. Moreover, the hydrate and potassium or sodium bichromate form a potassium or sodium mono-chromate and calcium chromate, the last mentioned possessing passive properties in a high degree, as demonstrated by the experiments.

Then cements were made with solutions of chromates to test the protective action, and also with ordinary water, for comparison. A polished steel plate was coated with this cement, the weight of the coat being estimated dry and made equal for all the plates of the same series. The other side of the plate and edges were washed over with an asphalte varnish. It was noted, and this is a very important point, that adhesion of the cement to the iron varies considerably with the amount of water. When the cement is too dry it separates from the metal in drying, whilst with a suitable quantity of water (40 per

cent to 50 per cent) a crust forms on the metal. When frequently covered with water during the first five or six days this crust adheres so firmly that it cannot be detached even by striking it repeatedly with a hammer.

When the cement had hardened the plates were laid with the cement side uppermost in glass dishes containing a layer of water. Then the plates were sprayed once daily with a mixture of equal parts of distilled water and Seltzer water, i.e., water containing carbonic acid. The dishes were then closed with a glass lid, and kept at an ordinary temperature. After a few weeks or some months the plates with ordinary cement were spotted with rust, whereas the others were absolutely free from rust.

How Iron Can Be Protected from Oxidation.—According to these experiments iron in concrete can be protected against oxidation in two ways. In the first place it can be coated over with a chromate cement and, when this has set, embedded in concrete in the ordinary way, or, second, the concrete can be mixed with the chromate water.

The first method has the advantage of thoroughly protecting the iron, more so as the thin coat of cement cannot crack when properly applied, and the consumption of chromate is relatively small. Plates thus treated and kept for a year on the roof of the Zurich Institute for Testing Building Materials, exposed to all kinds of weather, were perfectly free from cracks and rust. There is no risk, in this method, of the water in the concrete affecting the chromate in the cement, as demonstrated by the following test. Iron bars, 150 millimetres long and 18 in diameter, were coated with portland cement and a concentrated solution of calcium chromate, and other bars with the same cement mixed with a 5 per cent potassium bichromate solution, then left for 24 hours to set. They were then put into an iron mould, which was afterwards filled with concrete made with 1 part portland and 3 parts of normal sand, mixed with 10 per cent of water. After eight days the two blocks were worked with a hammer and chisel until the thickness of the concrete on the bars was only two or three millimetres. Finally the remaining concrete was filed off from the coating of cement and the dust removed by lengthy immersion in hot water. The filtered water had not the least tint of yellow, a proof that the chromate cement was not affected by the wet concrete.

In the second test the concrete mixed with the chromate solution was used. As yet the results of experiments on a large scale are not available, but it may be taken for granted that the effect is the same and perhaps better than in the first method, as the quantity of chromate is relatively much greater compared with the mass of iron, an important point, already noted by Heyn.

A test was made which demonstrated that chromates have no effect on the setting and resistance of cement.

Only practical experiments, on a large scale, can show which of these two methods is preferable. Consumption of chromate, the price of which is not negligible, is much less in the first than in the second method; moreover, the cement coat protects the iron against rust much better than a meagre porous concrete. On the other hand, coating iron with chromate cement involves expense, whilst the second method requires a greater percentage of protective materials but has the advantage of greater simplicity as the chromate solution supplied by the maker in the proper percentage can be added to the water when making the concrete. The extra expense estimated on the basis of Zurich prices would be 3 to 4 per cent. As previously observed, iron is thus only protected against ordinary atmospheric effects. Acid emanations, for example, would decompose chromates.

Training School for Bricklayers

A training school for bricklayers has been conducted by the General Contractors of St. Paul and Minneapolis since March, 1921. A fund was subscribed for it, and a competent bricklayer hired as instructor. The response to public notices given has been quite ample, and the school is expected to be permanent. The course is for six months, at a tuition charge of $5, which is refunded to those who attend 75 per cent of the sessions. There are no age restrictions, and the best students are found to be from 24 to 35. The cost of training a man is about $350; the average time required is five months, at an average cost of $7 a month; and 100 students are now enrolled.

Why Some Structures Fail

Interesting Failures in Structural Work Cited in The Canadian Engineer

By R. FLEMING,
American Bridge Co., New York.

Study of structural failures brings to mind such monumental disasters as the collapse of the Tay and Quebec bridges or the more recent one of the Knickerbocker theater, Washington. But the whole history of structural engineering is dotted with failures. Their varied nature may be inferred from the following titles taken from Engineering News-Record of the past three years:

Ford Car Wrecks Steel Bridge;

Floors Fall During Reconstruction of a Philadelphia Building;

Rusted Columns of Tank Tower Buckle;

Shallow Foundation Causes Building Failure;

Overloaded Wall Buckles;

30-Ton Gantry Crane Blown Off Pier;

Dust Explosion at Large Chicago Grain Elevator—Steel and Concrete Superstructure Wrecked;

Bridge Accident at Chester, Pa., Causes 24 Deaths—Sidewalk Bracket Falls Under Weight of Crowd When Cracked Gusset Plate Tears Apart;

Column and Truss Bracing Blamed for Brooklyn Theater Collapse;

Flat-Slab Reservoir at Canton, Ohio, Collapses;

Trestle Collapse Due to Freshet;

Part of Old Nine-Story Building Collapses During Reconstruction;

Falsework Failure Wrecks Large Highway Bridge;

Erection Derrick Falls with Steel Framework of School.

The majority of failures, however, are not reported in the technical press. This is especially true if there are no serious results. And it is these minor failures that most interest the average structural engineer because they come within the range of his own experience.

Typical Unrecorded Failures.—A dozen failures and near-failures that have been brought to the attention of the writer and not heretofore recorded will be mentioned in what follows.

The latches and end supports of a railroad swing bridge were constantly getting out of order. The cause was finally attributed to long trains, mostly of coal cars, passing one way over the bridge fully loaded while the trains passing the other way were almost invariably of empty cars.

A railroad bridge in New York was on a skew, one truss being fully a panel ahead of the other. After the bridge had been in use two or three months, word came to the fabricating firm that the counters in one of the panels were stressed under certain conditions to 22,000 or 24,000 lb. per sq. in. Those were the days of iron. The erector on being asked where he had placed the counters wrote back, "I put the biggest diagonals where there was the biggest strain." The marking plan was none too clear, so he discarded it and used his own judgment with the result that he had interchanged the main and counter ties. An erection gang was sent at once to correct his mistake. Why did the structure stand during the few months before the change was made?

A highway bridge in Texas rested on cylinder piers, consisting of iron cylinders filled with concrete. The butt end of a tree brought down the river by a freshet owing to an eddy in the swift current entered between the two cylinders at one end instead of passing by them. It was soon stopped, the tree swung round and acting as a lever overturned one of the piers and the span dropped.

Bull Topples Bridge.—Some cattle were being driven across a highway bridge in Connecticut. The bull balked and backed himself against the low pony truss with such force that it toppled over. The bull was killed and the bridge wrecked.

A train shed with open sides and sheet metal covering on roof and gables was wrecked in a wind storm. The wind blew from beneath and so well was the covering fastened that the trusses were wrenched from the columns. In cup-shaped sections exposed to wind the pressure is problematical and a liberal assumption should be made in design.

In one of the largest office buildings in New York City the superintendent's attention was directed to a certain floor that showed signs of distress. The tenant of the office in question

had filled it with steel shapes and models, greatly overloading the floors. This led to the employment of an engineer to examine the loads on the floors of every room in the building, with the result that three or four of more than ordinary weight were peremptorily ordered to be removed.

In another building a few blocks away, occupied mostly by jewellers, three or four columns were settling considerably and cracking the walls. It was found that on several floors heavy safes had been set against the walls in almost the same location.

The upper story of an industrial building was used as an office. The roof trusses had been built with rather heavy bottom chords. So a light floor was built upon them, and the space gained used to store papers and records. This was continued for several years until a warning caused an investigation of strength to be made. The haste with which boxes filled with books and papers were removed was quite remarkable.

Dust Load Disastrous.—During a long dry season nearly an inch of dust collected on one of the roofs of a cement plant. A heavy shower came, a cloud-burst, the dust was carried into the valley gutter, making such a load that several trusses sheared off at the heel and dropped.

A yard crane runway was thrown out of alignment by an outward movement of the columns. Lateral pressure was transmitted through the not very compact soil by the great heaps of scrap iron piled near the tops of piers, pushing them and the bases of columns sideways. The late James Christie for his own work insisted that out-of-door crane runways, especially those on made ground, should have the supporting columns extended to carry a system of horizontal bracing above and across the runway. The reason he gave was that if any settlement of piers took place the rails and girders would be kept the same distance center to center. An instance, however, where this is not sufficient is a runway in a manufacturing building where the crane girders are attached to the columns carrying the roof trusses. Raw material piled near the columns have pushed the piers laterally. The bottom chords of the roof trusses have buckled, throwing the crane rails and girders badly out of alignment.

The concrete piers supporting a large tower of a transmission line were filled with cracks and beginning to disintegrate. The tower was of the common 4-leg type with angle diagonals on each vertical face from the base of each leg. The owners claimed that the cracking of the piers was due to the absence of a horizontal tie or strut connecting the bottoms of the legs. The engineer sent by the firm fabricating the steel work to make an investigation found that the anchor bolts had been set in collars, that the spaces left by the collars after being withdrawn had not been filled with concrete and were filled with water. This gave the solution at once. During the previous winter the water had frozen and cracked the concrete.

Frost Failures. — Failures from water freezing and bursting its confines are not uncommon. In one case a score of cast iron column bases that had not been embedded in concrete became filled with water and cracked during the first winter from the water freezing. They had to be replaced at considerable expense. "Weep holes" should always be provided for the closed portions of castings. If not done water is liable to collect at the foundry before shipment, during transportation, or at the site before erection.

Can failures in structural work be prevented? Not altogether. Accidents, which no amount of human forethought can avert, will continue to occur to the end of time. Even failures due to faulty design, poor details, carelessness in erection, are preventable only in a measure. Experience is the great teacher. It is said that Brunel would congratulate his employers upon the failure of a bridge on the score of its preventing the erection of a hundred more on the same plan. The failure of the Tay bridge led to a new study of wind pressures and wind stresses. The Quebec bridge disaster led to a study of the latticing of compression members. The frequency of highway bridge failures under motor trucks is leading to an examination of existing bridges. Sane building regulations with competent enforcement will undoubtedly do much in the way of lessening the number of failures and accidents but will not entirely abolish them.

Comparative Test of Haydite and Rock Concrete Beams

On account of the proposal to use Haydite concrete in several important buildings in Oklahoma City, Okla., it was decided to make a comparative test, using concrete made with Haydite aggregate in one case, and concrete made with the local rock and sand aggregate in the other case. The test is described in the Western Contractor by B. S. Myers, Chief Engineer, Capitol Steel & Iron Co., Oklahoma City. We quote from his article as follows:

The quantity of the Haydite available for this test was very limited, and the size of the test beams were restricted accordingly. The Haydite used was obtained from a local contractor who had been furnished the material from regular stock of The Haydite Co. of Kansas City, Mo.

The beams tested were "T" section, being 6 in. deep and 5 in. wide, and the flange 2 in. thick and 12 in. wide. The beams were reinforced at the bottom by 2⅞-in. round rods with 5/16-in. round stirrups at 5 in. centers.

The test beams were reinforced sufficiently to guarantee failure in the concrete in compression. In both cases the concrete was proportioned carefully by volume, a 1:2:4 mixture being used. A minimum amount of water was used to secure a workable mixture, and the same care was used in mixing and placing the concrete in both cases.

After the beams were poured, they were placed in a room in which the temperature was kept at about 70° day and night until the test was made on the tenth day. The test specimens were covered with sand and kept well wet down twice each day.

How the Test Was Made.—The beams were supported on rocker bearings, consisting of two steel plates 6 in. by ½ in. by 1 ft. 0 in. with a 1⅛ in. round steel rod between the two plates. The loads were applied in increments of 1,000 lbs. and 1¼ in. square reinforcing bars were used for the loading. A wood block 5 in. by 2 in. by 1 ft. 2 in. was placed in the center of the beam to receive the load and to prevent any of the load being applied at the edge of the flanges of the beam. The first layer of bars had a total weight of 1,500 lbs. and were placed on the beam with one end of the bars resting on a platform scale. The bars were shifted in position until the scale registered a weight of exactly 500 lbs. The additional layers of bars, weighing 1,000 lbs. each were placed in position on the beam so as to maintain the 500 lbs. balance on the scale.

Results of the Test.—The following table shows the theoretical stresses on the steel and the concrete, and the deflection of the beams 7 in. from the center line for the load indicated:

Load, lbs.	Stress, lb. per sq. in. Steel.	Stress, lb. per sq. in. Concrete.	Deflection. Stone and sand. In.	Deflection. Haydite. In.
1,000	6,000	425	.11	.13
2,000	12,000	850	.21	.24
3,000	18,000	1,275	.32	.36
4,000	24,000	1,700	.44	.48
5,000	30,000	2,125	.59	.61
6,000	36,000	2,550	.75	.75
7,000	42,000	2,975	1.02	.93
7,300	43,000	3,112	....	....
8,000	48,000	3,400	....	1.60

The beam made of rock and sand concrete required a load of 7,300 lbs. to cause failure at which time the concrete was stressed to 3,112 lbs. per square inch. The concrete in this beam was very dense, and the beam had a smooth, neat appearance when the forms were removed. When the forms were removed from the Haydite beam, the concrete appeared to be quite porous and of not as good a quality as the other beam.

About 25 engineers and architects witnessed the test, and it was their unanimous opinion that the Haydite beam would fail under a considerable less load than the rock and sand concrete beam. However, a load of 8,000 lbs. was required to cause failure, at which time the concrete was stressed to 3,400 lbs. per square inch maximum. The beams were weighed in order to determine the weight of the concrete per cubic foot in each beam. The Haydite concrete weighed 108 lbs. per cubic foot and the rock and sand concrete 144 lbs. per cubic foot.

Haydite is an artificial aggregate for concrete, made by burning clay or shale to a clinker in much the same way as the clinker is formed in the process of manufacturing cement. This clinker is placed in stock piles and crushed to the desired sizes required for the making of concrete.

The California Day Labor Law

The new law passed this year by the Legislature of California relating to public work done by day labor requires the filing of a certificate by public officials showing the total cost of the work they do by day labor. The provisions of the law are as follows:

Section 1.—It shall be the duty of the state highway engineer, the state engineer, the state architect and of every county engineer, county surveyor, city and county engineer, county highway engineer, road commissioner, city engineer, commissioner of public works, superintendent of streets, harbor engineer, flood control engineer, and the engineer of any reclamation, irrigation or other district, political subdivision or agency of the state directing, supervising or superintending the construction, or in charge of engineering work for or in connection with the construction of any bridge, road, street, highway, ditch, canal, dam, tunnel, excavation, building or structure within the state by day's labor or force account, except emergency and maintenance work and work costing less than ten thousand dollars.

(a) to keep accurate account of the cost of such work,

(b) to prepare and file in his office, prior to the commencement of the work, full, complete and accurate plans and specifications, and an estimate of the cost thereof, except where other and adequate provision is made by law requiring the preparation and filing of such plans, specifications and estimates of cost by some other officer or in some other office; and,

(c) upon completion of any work, to prepare and file in the office of the county clerk of the county in which the work is performed, or if any such reclamation, irrigation or other district maintains an office then in the office of his own such district instead of the office of the county clerk, a certificate in writing verified by him, in the same manner as complaints in civil actions, setting forth

(d) the estimate of cost,

(e) names of bidders with prices bid,

(f) changes in adopted or approved plans and specifications.

(g) that the work performed has or has not been done in accordance with such plans and specifications,

(h) a list of any publicly-owned equipment used in the work, and

(i) an itemized statement of the actual cost of all labor, materials, rentals, repairs, compensation, and other insurance, transportation of labor, equipment and materials, engineering or architectural services including the services of public employees in connection with the work, and any and all other cost entering into the work performed.

(j) including a reasonable amount for depreciation of publicily-owned equipment used in the work and the cost of repairs thereon while so used.

Section 2.—Such plans, specifications and certificates shall be open to inspection and examination as a public record.

Sales of Federal Timber

Sales of timber from the national forests during the fiscal year ending June 30 were greater than in any like period, the Forest Service, United States Department of Agriculture, has announced.

With the recent sale of 685 million board feet, mostly Douglas fir, from the Cascade National Forest in Oregon, the total for the 12 months is between 2,500 million and 3,000 million board feet, according to preliminary figures. The estimated cut will be between 900 million and 1,000 million board feet, the latter figure representing an increase of nearly 250 million board feet over the cut of the preceding fiscal year.

Management plans for the national forests provide for the cutting and removal of the matured crop of timber in such a manner that reforestation of the cut-over areas will insure a perpetual timber supply. Units of management called working circles are laid out and a limitation of cut fixed for each.

In some areas the timber is clean cut, and a new stand is obtained by leaving seed trees; but in most instances the smaller trees left standing constitute the next potential cut. Artificial restocking or planting of young trees is confined almost entirely to old burned-over areas upon which nature is exceedingly slow in establishing tree growth.

From 40 to upwards of 100 years are required to complete the cutting and removal of timber from the usual working circle, thus providing for a new growth of matured timber by the time the sawyer returns to the starting point.

Engineering Office Standards

The need for universal standard for the drafting room is pointed out by Robert W. Shelmire in an article in the Professional Engineer, from which we quote the following:

Every company has its own set of standards and how jealous they are of them. But why do not engineers see the desirability of universal standards rather than standards useful in one office only? Each plant must standardize work to suit its own equipment, of course, but numerous things could be standardized and made universal at least throughout the English speaking world.

Those who despise standards on general principles probably want to know, "What, for instance?" Threads, rails, building codes, the sizes of drawings and many other things. If engineers could come to some agreement on rail sections there would be millions saved in the manufacture of frogs, switches, angle bars, and attachments not to mention the saving in rolling-mill equipment. If engineers had cooperated years ago and adopted universal fire hose couplings, part of Baltimore burned in the great fire might have been saved. As it was, engines from adjacent cities had different threads on their hose couplings.

My present purpose, however, is not so broad. It is not necessary to scrap all the machinery now in use in order that the world may be standardized. It is only desired to call attention to a few things that would tend to simplify office details. To have a standard list of abbreviations for use on drawings among English speaking people would be very useful. It should not be a book containing all the words it is possible to shorten for this would defeat the very object of simplicity. There are now too many miscellaneous words abbreviated. What we need is a short list of abbreviations, of the words used most frequently.

An examination of drawings from various offices discloses a lack of uniformity on this point, and many words are abbreviated in more than one way. "Plate" is usually shortened to pl. but sometimes to p. and plt. "Bottom"; bot., bott., btm. "Special"; sp., spc., spl. What is the sense of abbreviating a word of only six letters to four letters and a period? And how absurd to abbreviate such a word as "special" in order to save two or three letters and thereby interpose some doubt as to its meaning when the very nature of the word calls for particular attention. If R. C. indicates "rain conductor" then it ought not to mean "reinforced concrete." H. P. stands for "horse power." Therefore, it is best not to abbreviate "high pressure" or "hydraulic pressure" in the same way. No one but a lazy draftsman would abbreviate "steel" to stl. but it is often done just to save two small e's. T. C. D. according to one architect means "terra cotta drain." E. O. T. means "electric overhead traveling" (crane). There is no limit to abbreviations such as these which cause no amount of trouble.

Nearly every writer who gives a list of abbreviations limits its use to one particular branch of engineering. Drawings circulate among all the various tradesmen and classes of engineers so there is no justification for limiting standards of this nature to one class of work. What must the carpenter and the plumber say when they compare drawings with different nomenclature on the same job? The problem is not a local one though, for the work may be in Australia and the drawings come from both England and America. We need universal standards because drafting is a univarsal language. The world has shrunk in the last few years. America is isolated no more. Methods of projection, symbols, abbreviations, systems of weights and measures and numerous fundamentals used in engineering and architectural office practice must eventually be made common to all countries. Why not begin to think about it now?

Not the least of the benefits to be derived from a more uniform practice in the art of drafting is the greater efficiency which follows any simplifying process. Draftsmen who must shift frequently from office to office, instead of spending weeks and months learning office standards each time, would have to learn them but once; that is to say, those things which would yield to a universal standard. I have known a good engineering draftsman to require four months to pick up his accustomed speed after shifting to a new office, much of this time being spent in learning different ways of doing the same things. Standards should only be adopted through a representative body. We have too many one-man standards now.

Tests of Hollow Tile and Reinforced Concrete Floors

Some time ago the U. S. Bureau of Standards conducted an investigation of the stresses in certain of the floor panels of the Arlington Building, Washington, D. C. This building was designed for use as a hotel, but was purchased by the Government and occupied by a branch of the Treasury Department. This change of occupancy considerably increased the live load which was taken care of by an additional layer of concrete on top of the floor panels. These panels are constructed of hollow tile and reinforced concrete supported on reinforced concrete beams. The tests are of unusual interest because they were among the first made on this type of construction and because of the provision above mentioned for carrying the additional load.

The test loads, consisting of bags of cement, were designed to produce the maximum positive and negative moments. Strain measurements were taken of the concrete and the reinforcing steel of the slabs and girders. In addition the deflections of the slab were measured, and it was found that the maximum stresses were developed at the positions of negative moment in the vicinity of the supporting beams. The beams at the edges of the panels offered so little resistance to torsion that the stresses in the steel across these beams, due to negative moment, were but little affected by transfer of load between adjacent panels. While under load, the effect of time was very pronounced during the first 20 hours and comparatively small later. The increase in the deformation, due to continued loading was greater in the reinforcement than in the concrete. The cracking of the concrete and the resulting great increase of the stresses in the reinforcing steel show that at first the concrete carried a considerable portion of the tensile stresses.

The moment coefficients were generally small, and the Bureau does not suggest them for use in design, but simply to show the relative amount of the bending moment carried in the two directions. The effect on the moment coefficient of an increase in ratio of length to width of the panel was a rapid increase of both positive and negative moments in the direction of the short span and a less rapid decrease of both moments in the direction of the long span. The factor of safety in the structure was apparently greater than 2.

This investigation is described in Technologic Paper No. 236 of the Bureau of Standards which can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 15 cts. a copy.

A. A. E. to Ask Congressional Investigation of Davis Dismissal

Request for a Congressional investigation of the dismissal of Arthur P. Davis as Director of the United States Reclamation Service was decided upon by President Webster L. Benham of the American Association of Engineers when he was in Chicago on July 14, and received reports on the situation. The Civil Service Reform League has been requested to look into the circumstances of the dismissal and take appropriate action.

"Information from several sources all point to this course as the wise one," said President Webster L. Benham. "We admit at the outset that in the selection of an executive, the person directly responsible for the work is entitled to exercise his judgment in appointing his subordinates. While this is the essence of executive control, we view with grave concern the dismissal without notice of an admittedly capable engineer who has been in administrative charge of an important government service for many years. We are particularly concerned in that such discharge is purported to have been accompanied by threats intended to intimidate Mr. Davis into giving out publicly a statement that the resignation was initiated by himself."

"As I see the Reclamation Service, in its present stage," continued President Benham, "It is a question of administration, in which understanding of the engineering side is important. An engineering administrator is the kind of business man who can best serve the public in an essentially engineering undertaking and many men of this kind have been developed in the Reclamation Service.

"An insistent demand, it is true, is being made by farmers on the Reclamation projects to escape making the low payments of principal without interest for the works they are buying from the Government. That the farm-

er has been badly off economically, every one knows, but I do not believe those on the Reclamation Projects are any worse off than farmers in Kansas, Iowa, Oklahoma, Illinois, or Ohio, or should be any more readily excused from paying their just debts.

"The Reclamation Law requires the repayment of monies invested by those benefited. Those who try to escape, seek to discredit the work and thus avoid repayment. By cutting off the repayments, the large revolving fund provided by the law will be destroyed, and the whole work will stop, with the consequent loss of potential homes for the American people.

"These considerations have caused the American Association of Engineers, with its 175 chapters and 15,000 members, to instruct its Committee on Political Policies to ask for Congressional investigation."

The Effect of Accelerators on Reinforcing Steel

A number of 1:2:4 concrete and 1:3 mortar specimens in which steel rods have been embedded were broken during the past month, and an examination made of the rods by the U. S. Bureau of Standards. Calcium chloride solutions had been used for some of the specimens as the gaging liquid. An examination was also made of expanded metal which had been embedded in small slabs prepared from mortar gaged with a proprietory compound of the accelerator type.

Some of the foregoing specimens were 5 and others 6 years old and all had been stored out of doors and exposed to the weather. According to a Technical News Bulletin of the Bureau, from this examination, it is concluded that while calcium chloride tends to corrode the reinforcement, the corrosion does not seem serious or of a progressive nature with age, in cases where the reinforcement is completely embedded in the concrete. However, when using accelerators care should be taken to completely coat and embed the reinforcement and avoid pockets near it. The strength of the specimens which had been exposed to the weather was considerably higher when calcium chloride had been used than when it had not been employed. Sufficient specimens remain to allow another examination at a later date, and a comparison of the rod condition and strength will be made at different ages.

Seasonable Operation in the Construction Industries

A committee has been appointed by Herbert Hoover to make a study of seasonable operation in construction. Commenting on the work of this committee a news letter of the Associate General Contractors says:

"Previous surveys have indicated that most construction activity is concentrated in seven to ten months of the year, which means that building trades workers cannot find work in their trade during several months and that contractors' organizations and equipment, architects, engineers, building material producers, and others connected with construction must usually remain idle for similar periods. This idle time represents waste and direct losses to the construction industries themselves, their workers, and the public.

"The committee was formed in the hope that by examining the facts and proposed remedies it might be able to suggest sound solutions and obtain general cooperation in effecting them. It is the general impression that seasonal building has been due perhaps more to custom than to weather, and it is expected that the investigation will throw light on this and other important points."

Large Granite Block Quarried by Means of Wedges.—An unusually large split that separated a piece of stone from the main sheet, 267 ft. long, 20 ft. wide and an average depth of 8 ft., was made recently at the quarry of the John L. Goss Corporation, at Stonington, Me., according to "Stone." Larger blocks have been started in the Goss quarries, but with powder, while this great shaft of granite was split with 3-in. wedges. A few deep holes were drilled in the long line to explode powder in order to loosen the split and save the wedges, as there were some 2,400 of them. The block is said to be perfect in every way. Reports from Carrara, Italy, state that there will shortly be moved there a single block of marble weighing 50,000 tons. It has taken eight months to quarry this enormous mass, it being necessary to construct a 35-yd. gallery for its removal from the bed.

Monthly Statistics of the Building Industry

The accompanying tabulations are taken from the Survey of Current Business, a publication of the U. S. Department of Commerce. They show (1) the building contracts awarded by thousands of square feet, and thousands of dollars, (2) the index numbers for building contracts awarded, (3) the building material price index for frame and brick houses, (4) the cost index for constructing factory buildings, and (5) the index numbers of wholesale prices for structural steel, iron and steel, composite steel and composite finished steel.

The figures on building contracts are based on data compiled by the F. W. Dodge Co., covering small towns and rural districts as well as large cities in 27 northeastern states. Prior to May, 1921, the building figures covered 25 northeastern states and the District of Columbia. The states are those north and east of, and including, North Dakota, South Dakota, Iowa, Missouri, Tennessee, and Virginia, together with portions of eastern Kansas and Nebraska. Beginning May, 1921, North Carolina and South Carolina were added to the list, but this addition is stated to have little effect upon the total.

The price indexes for frame and brick houses are from the U. S. Department of Commerce, Bureau of

	Grand Total Building Contracts		Index Numbers		Building Material Price Indexes		Cost Index	Wholesale Prices			
Year and Month	Thousands of sq. ft.	Thousands of dollars	Sq. ft.	Value	Frame house	Brick house	Factory building costs	Structural steel beams (Pittsburgh)	Iron and steel	Composite steel	Composite finished steel
1913 monthly av.	.....	$71,475	.....	33	100	100	.....	100	100	100	100
1914 monthly av.	.....	60,020	.....	28	.....	.....	100	83	87	88	86
1915 monthly av.	.....	78,341	.....	36	.....	.....	.....	93	94	95	92
1916 monthly av.	.....	113,082	.....	53	.....	.....	.....	177	154	163	161
1917 monthly av.	.....	134,086	.....	63	.....	.....	.....	269	266	259	252
1918 monthly av.	.....	140,770	.....	65	.....	.....	.....	202	215	220	213
1919 monthly av.	46,683	214,990	100	100	.....	.....	.....	174	191	193	188
1920 monthly av.	33,491	211,102	72	98	.....	.....	.....	187	249	211	222
1921 monthly av.	32,267	196,648	69	91	.....	.....	179	131	155	156	152
1922 monthly av.	47,745	279,410	102	130	182	186	170	115	144	134	134
1921											
January	15,513	111,608	33	52	.....	.....	.....	.....	.....	.....	.....
February	16,807	100,677	36	47	.....	.....	.....	.....	.....	.....	.....
March	26,709	164,092	57	76	.....	.....	.....	.....	.....	.....	.....
April	34,494	220,886	74	103	.....	.....	.....	.....	.....	.....	.....
May	35,751	242,094	77	113	.....	.....	176	146	165	170	166
June	35,738	227,711	77	106	.....	.....	172	146	159	165	159
July	31,717	212,491	68	99	.....	.....	167	139	145	153	148
August	35,246	220,721	76	103	.....	.....	161	123	137	144	141
September	41,702	246,186	89	115	.....	.....	160	123	134	138	136
October	40,436	222,480	87	103	.....	.....	157	116	135	134	134
November	37,818	192,311	81	89	166	173	154	106	132	133	128
December	35,272	198,518	76	92	173	179	153	99	129	130	127
1922											
January	30,261	166,320	65	77	174	179	152	99	127	126	124
February	30,061	177,473	64	83	169	174	152	96	125	124	121
March	51,957	293,637	111	137	169	173	152	96	125	122	122
April	58,146	353,162	125	164	168	172	152	99	131	126	125
May	59,639	362,590	128	169	173	176	157	106	139	127	127
June	60,526	343,440	130	160	178	181	169	106	140	129	130
July	51,705	350,081	111	163	181	184	171	109	142	130	131
August	54,019	322,007	116	150	189	193	174	116	151	137	138
September	44,275	271,493	95	126	193	197	190	137	166	146	146
October	46,806	253,137	100	118	196	199	192	141	166	149	148
November	46,946	244,366	101	114	196	201	192	136	160	149	146
December	38,603	215,213	83	100	192	198	192	132	154	149	147
1923											
January	38,947	217,333	83	101	195	199	192	132	156	151	149
February	41,611	229,938	89	107	198	201	197	139	162	158	157
March	64,920	333,518	139	155	209	209	197	146	179	165	163
April	64,527	357,475	138	166	.....	.....	204	.....	.....	.....	.....

Standards, Division of Building and Housing and Bureau of Census, and are based on prices paid for material by contractors in some 60 cities of the United States. The prices are weighted by the relative importance of each commodity in the construction of a 6-room house.

The index number for constructing factory buildings is furnished by Aberthaw Construction Co., and is designed to show the relative changes in the cost of constructing a standard concrete factory building. The company believes that the year 1914 gives a normal base and that July, 1920, with an index number of 265, represented the peak of costs.

The index numbers of wholesale prices for structural steel, etc., are obtained as follows: The prices for structural steel beams are the average of weekly prices from the U. S. Department of Labor, Bureau of Labor Statistics. The figures for iron and steel are the average of weekly prices compiled by the Iron Trade Review on the following 14 products: Pig iron, billets, slabs, sheet bars, wire rods, steel bars, plates, structural shapes, black galvanized and blue annealed sheets, tin plates, wire nails, and black pipe. Pig iron average in turn is aver- of 13 different quotations.

The figures for composite steel are compiled by the American Metal Market and represent the average price per pound of steel products weighted as follows: 2½ lb. bars, 1½ lb. plates, 1½ lb. shapes, 1½ lb. pipe, 1½ lb. wire nails, 1 lb. galvanized sheets, and ½ lb. tin plate.

The composite price of finished steel products is compiled by the Iron Age. It includes: Steel bars, beams, tank plates, plain wire, open-hearth rails, black pipe, and black sheets. These products, according to the Iron Age, constitute 88 per cent of the United States output of finished steel.

Record Book for Wire Rope Users

Forms for keeping service records of wire rope are an important feature of a new reference book and catalog of the Williamsport Wire Rope Co., Williamsport, Pa. These forms enable the user to keep an accurate history of the rope. In addition the publication contains useful information on the most common causes that shorten the life of wire rope in various operations; it gives directions for splicing and data on finding breaking strength, lengths required to make ropes endless, horsepower transmitted by wire rope, etc. It also contains numerous tables relating to the various uses of wire rope, and information on the various classes of rope made by the company.

INDUSTRIAL NOTES

The Ginsberg-Penn Co., Inc., 50 Church St., New York, sales representatives for construction machinery, has recently been appointed, effective Aug. 1, by the Byers Machine Co., Ravenna, O., to take on exclusive distribution in their territory of its entire line of locomotive, auto and truckranes. The Ginsberg-Penn Co., Inc., consists of Frank I. Ginsberg, president, formerly with R. E. Brooks and Insley, and Hamilton O. Penn, formerly of the T. L. Smith Co., Milwaukee.

The Portland Cement Association announces the appointment of James A. Hudson as district engineer in charge of a new association office just opened in Memphis in the Exchange building. This office will have charge of association activities in Tennessee.

The Bucyrus Co., South Milwaukee, Wis., announces the appointment of E. J. Wilkie as northern sales manager to succeed E. R. Weber, resigned. Mr. Wilkie will have general charge of the sale of Bucyrus products in Wisconsin, Minnesota, North and South Dakota, Upper Peninsula of Michigan and Eastern Montana, with headquarters in South Milwaukee, Wis.

Chicago Pneumatic Tool Co., 6-8 East 44th St., New York, announces the removal of its Philadelphia office and service department from 140 Market St. to 237 North 12th St.

William C. Frye, for seven years president of the Chain Belt Co., Milwaukee, Wis., has retired from active participation in its affairs and has been succeeded by C. R. Messinger, vice president and general manager since 1917. Mr. Frye is retiring after an active association with the company for 28 years. During this time he has occupied practically all the important executive positions and just previous to his election as president in 1916 was treasurer. Under his leadership the company continued the steady growth inaugurated by C. W. Levally, founder and first president, and is today one of the largest and best known producers of chain, concrete mixers and conveying machinery in the country, all of which are manufactured under the trade name of Rex. Mr. Messinger, who succeeds Mr. Frye, became associated with the Chain Belt Co. in 1917 after eight years as general manager of the Sivyer Steel Casting Co. He is also president of the Interstate Drop Forge Co., vice president of the Sivyer Steel Casting Co., vice president of the Federal Malleable Co., all of Milwaukee, and a director in the Nugent Steel Castings Co. of Chicago and the First Wisconsin National Bank of Milwaukee. During the term 1922-23 Mr. Messinger was president of the American Foundrymen's Association and is also prominent in the affairs of the American Malleable Castings Association.

Roads and Streets

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.

221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*

LEWIS S. LOUER, *Vice-President and General Manager*

New York Office: 904 Longacre Bldg., 42d St. and Broadway

RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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Vol. LX. CHICAGO, ILL., AUGUST 1, 1923 No. 2

The Wall Street Myth

So often has it been said that the price level of stocks is an infallible barometer of business conditions that most men have come to believe the statement. But a study of the curve of stock prices discloses nothing else than a sensitive weather vane which is as apt to swing violently under a puff of wind as under a hurricane. The weather vane may show that the direction of the wind has changed but fail to show either how long it will remain as it is or how violently the wind will blow.

Starting last March, the price level of stocks began to fall, and as the decline continued week after week, many business men began to worry, for the Wall Street myth that stock prices are a trade barometer still controls many of the actions of many men. But about a month ago the wind veered and the stock market weather vane responded. Stock prices began to rise, and now the future looks less dismal for those who follow the ticker.

Almost exactly four years ago a similar phenomenon occurred. Between July 14 and August 7, 1919, stock prices declined from a level of 112 to 100, and there was a near panic among the myth believers. The great post-war depression was at hand, they said. But two weeks later stock prices began to rise rapidly, and by November 2 had reached a level of 120. Thereupon loud cries of delight came from the stock myth worshipers. Now they were sure that no business reaction would occur for a long time. Yet by April, 1920, the stock price level had receded to 100, and the "panic" of 1920 had begun.

Such experiences as this, and they are many, show that while the price level of stocks usually moves in advance of the price level of commodities, it furnishes no reliable criterion of the trend of business prosperity. In fact, so long as the price of stocks is regarded by many men as being a trade barometer it cannot act as a reliable barometer, for the very fear that a falling stock market forecasts business decline tends to promote such

a decline in some measure, and in still greater degree it promotes the decline of stock prices. If there has been no great over-production of commodities in excess of the buying power of wage incomes, a serious business depression cannot occur; but even in the absence of this condition, a frightened flock of lambs, to whom the tickers' low tones are the growls of the wolf, will rush bleating away from stocks. It really is an amusing example of economic ignorance to attribute to such lambs a power of foresight that none of them individually dares claim and that all of them collectively obviously do not possess.

Once the stampede of the speculative lambs has begun, its increasing violence is assured, for large blocks of stock are purposely thrown on the market by the canny wolves of Wall Street. The bleating increases in pitch and violence, for a time, but at last the lambs, wise prophets of future business conditions, fall exhausted and another world crisis ends.

There is nothing more astonishing in the whole realm of economics than the wide swings of this weather vane of stock prices, so long miscalled a barometer of trade. Today stocks in companies having large surpluses and great earning power are selling at 110; a month hence they may be selling at 90; two months later at 120. And the average man who is buying and selling in such a squall is seriously said to possess business foresight! For if he possesses no foresight, then why dignify by the term trade barometer the prices that he is instrumental in creating? Let us call these stock prices by a truer title, the stock market weather vane. And let us realize that the wind that moves it is very often only that caused by the fanning of the air by the lambs in panic flight.

$7,500,000 for Forest Roads.—Congress has authorized the United States Department of Agriculture to spend $7,500,000 on roads serving the national forests during the fiscal year ending July 1, 1924. Moreover, 25 per cent of the receipts from timber sales and grazing permits will yield around $1,325,000, according to advance estimates, which will be turned back as usual to the States for use on county schools and roads.

Mark Twain on Advertising

If a man were to make the best mouse traps in the world, and were his workshop in the center of a forest, the world would find him out and beat a path to his door. We have seen this anti-advertising sentiment ascribed by some to Emerson, by others to Hubbard, both idealists and ideal phrase makers. By way of contrast we may quote an anecdote about Mark Twain: As editor of a Missouri newspaper in his youth, he received a letter from a superstitious merchant who was a reader of Mark's editorials but not a buyer of his advertising space. The merchant opened his paper one morning and finding a spider crawling on the editorial page, wrote Mark asking whether it meant bad luck for him or for the editor. Mark printed this reply next day:

"Old Subscriber: The spider was merely looking over our paper to see which merchant is not advertising, so that he can go to that store, spin his web across the door, and live a life of undisturbed peace ever afterwards."

Weak Spots in Road Slabs

Editorial in The Canadian Engineer

One of the definite conclusions which may be drawn at the present time from the remarkable road tests that are being carried out on experimental roads in Illinois, California and Virginia, is that the edges and corners of slabs are important sources of weakness. It was found, for example, for the Bates road that for the edge close to which the traffic was allowed to run, the number of failures was very greatly in excess of those on the other edge of the pavement where traffic approached no closer than 2½ ft. This suggested the advisability of thickening the edges of the road slab, and such is being done on the new standard slab design for Illinois roads, based on the Bates tests. Another method of obviating edge failure would be to widen the road slab and perhaps mark a longitudinal centre line on the pavement so that the traffic would be coaxed away from the edges. Illinois highway officials, however, regard the thickening of the edges as the more desirable solution.

Corners of slabs are notoriously susceptible to rupture from concen-

crated loads. This fact was well known before large scale road tests demonstrated its existence experimentally. If, for example, a wheel load chances to pass over a transverse joint near the edge of the pavement, there is liability of the two outside corners being cracked off, unless the slab is well supported by the subgrade. If the temperature be low, and particularly if the pavement be dry, the corners will be curled up to a certain extent and will be in a position of free cantilevers. It is only a question of the magnitude of the load and the impact produced as to whether the corners will stand up under this treatment. Since transverse cracks are likely to occur at almost any cross-section of pavement which is not heavily reinforced, many potential outside corners exist in a road slab, with the result that a large number of edge failures might be expected during the course of cool weather or under night traffic. Thickening of the edges of slabs will, to some extent, obviate the danger from corner breakages, and the use of a continuous rod dowel along the edge, as is proposed by the Illinois highway authorities, will mutually support the two adjacent cantilevered corners with a result that the strength of each is perhaps doubled.

Observation and test have convinced many highway engineers that a longitudinal joint in a wide pavement is desirable. For pavements 16 or 18 ft. wide, it can hardly be expected that freedom from longitudinal cracking would be secured, having in mind the rising and falling of the slab at the centre due to temperature and moisture effects. Given a longitudinal joint, there then arises the incidental difficulty of rupture at interior corners. Wherever a transverse joint intersects a longitudinal joint, or wherever a transverse crack runs into it, corners are produced which act in some measure as cantilevers. The Illinois revised slab section provides for transverse dowels every 5 ft., thus holding the edges of the slab tightly together at the longitudinal joint and preventing free cantilever action. It is believed that much difficulty will be obviated by this simple device.

It is a matter of considerable satisfaction to the engineering profession to find the problems of road slab design being rapidly solved by intensive experimental and theoretical study. Some thirteen years ago inverted curbs or edge girders were adopted on the concrete road on Woodward avenue leading out of Detroit, under the belief that the edges were a source of weakness. Curiously enough, this was regarded by many as a bad design, and but few engineers had the courage of their convictions to thicken road slabs at the edges until large-scale research showed it to be desirable. However, it must be said that in both Arizona and California, a number of pioneer engineers did adopt this sound feature of design before the days of large-scale tests. What was a strong belief of certain far-sighted engineers has become a demonstrated fact, due to the concentrated efforts of scientific investigators. Highway construction is bound to benefit, and the people who pay for the roads to reap corresponding advantage, through the persistence and foresight of those who are attempting to solve the unknown elements in road slab design.

Pennsylvania Allows Low Bidders to Withdraw Bids Not Read

The Pennsylvania State Highway Department will, in the future, make a practice of checking all bids received and announcing the low bidder immediately after the reading of bids on each project. Where a concern is announced, as being low, and desires to withdraw any proposal which has not been read, they will be given the option of so doing, by personal request from their duly authenticated agent.

As has been pointed out before, remarks the Highway Builder, whenever there is a large letting of state highway work constructors who have equipment and organization idle, naturally and quite properly inspect and prepare bids on a larger number of projects than they expect to be called upon to build. This is necessary in order for them to secure the amount of work desired. In future, in Pennsylvania, when they find themselves low bidders on as many contracts as they feel capable of executing, they will have the privilege of withdrawing additional bids. This will protect them against overloading and will also protect other bidders from losing work through rejection of all proposals on a particular job, on account of the inability of the low bidder to qualify.

Motor Vehicle Production in June

The U. S. Department of Commerce announces June production of automobiles and trucks, based on figures received by the Bureau of the Census in cooperation with the National Automobile Chamber of Commerce and covering approximately 90 passenger-car and 80 truck manufacturers each month.

AUTOMOBILE PRODUCTION
(Number of Machines)

	Passenger Cars		Trucks	
	1923	1922	1923	1922
January	223,706	81,693	19,398	9,416
February	254,650	109,171	21,817	13,195
March	319,638	152,959	34,681	19,761
April	344,474	197,216	37,527	22,342
May	350,180	232,431	*43,012	23,788
June	336,317	263,027	40,565	25,984

*Revised.

Changes in Retail Prices of Food in the United States

The retail food index issued by the United States Department of Labor through the Bureau of Labor Statistics, shows that there was an increase of 1 per cent in the retail cost of food in June, 1923, as compared with May, 1923. In June, the index number was 144, in May, 143.

During the month from May 15, 1923, to June 15, 1923, 13 articles on which monthly prices are secured increased in price as follows: Potatoes, 19 per cent; round steak, 5 per cent; sirloin steak, leg of lamb and onions, 4 per cent; chuck roast and bananas, 3 per cent; rib roast and cheese, 2 per cent; ham and fresh eggs, 1 per cent. Vegetable lard and substitute and tea increased less than five-tenths of 1 per cent.

Fifteen articles decreased in price as follows: Cabbage, 23 per cent; butter, 4 per cent; hens, 2 per cent; oranges, 3 per cent; plate beef, lard, sugar, coffee, prunes, and raisins, 1 per cent; pork chops, bacon, canned salmon, nut margarine, and wheat cereal decreased less than five-tenths of 1 per cent.

Fifteen articles showed on change in price during the month. They were as follows: Fresh milk, evaporated milk, oleomargarine, bread, flour, corn meal, rolled oats, cornflakes, macaroni, rice, navy beans, baked beans, canned corn, canned peas, and canned tomatoes.

For the year period, June 15, 1922, to June 15, 1923, the increase in all articles of food combined was 3 per cent.

For the ten-year period, June 15, 1913, to June 15, 1923, the increase in all articles of food combined was 48 per cent.

Road and Street Contracts Awarded During the Last 42 Months

The accompanying table shows three outstanding facts: First, that highway contracts awarded during the last half of each year have averaged only 25 per cent less in volume than those awarded during the first half; second, that there is not a month in the year without a very large volume of road and street contracts awarded; third, that each year shows a substantial gain over its predecessor.

ROAD AND STREET CONTRACTS EXCEEDING $25,000 IN SIZE

	1920	1921	1922	1923
January	$ 12,204,000	$ 11,598,000	$ 14,424,000	$ 21,691,000
February	21,334,000	12,049,000	9,052,000	18,781,000
March	26,221,000	25,880,000	39,669,000	37,706,000
April	33,340,000	31,026,000	32,991,000	29,641,000
May	30,258,000	35,064,000	42,284,000	46,528,000
June	31,441,000	56,777,000	42,138,000	38,040,000
July	29,353,000	33,943,000	26,087,000	.....
August	18,565,000	28,693,000	37,035,000	.....
September	26,537,000	23,257,000	28,884,000	.....
October	12,894,000	20,055,000	23,162,000	.....
November	12,443,000	20,751,000	20,892,000	.....
December	10,834,000	16,263,000	18,096,000	.....
Total	$265,424,000	$315,356,000	$334,714,000	.....

Note.—About 100 per cent must be added to these totals to give the grand total of highway contracts in the United States.

Bridges are not included, and bridge contracts average 15 per cent as much in value as road and street contracts. A great deal of road and street work is done by directly hired labor and is not included above.

Effect of Repeated Loads on Concrete Slabs

Investigation of Fatigue Element of Cement Mortar Described in Paper Presented June 28 at 26th Annual Meeting of American Society for Testing Materials

By R. B. CREPPS
Assistant Professor of Testing Materials, Purdue University

The investigation of the fatigue element with respect to cement mortar is being carried on in the Testing Materials Laboratory of Purdue University as a co-operative project of the Engineering Experiment Station and the U. S. Bureau of Public Roads.

The Testing Apparatus—Deflections of a concrete slab occur in the form of a wave action as a wheel passes over the surface. The direction and nature of the resulting stress is constantly changing from tension of compression in the upper fibers to tension or compression in the lower

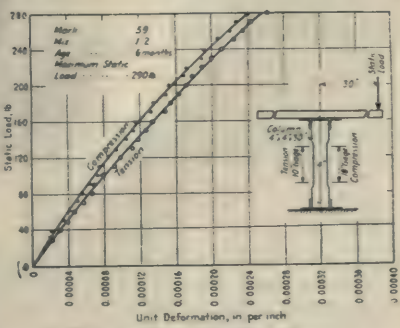


Fig. 1.—Static Loading Curve.

fibers. With these facts in mind the idea of investigating the effect of reversed stresses upon concrete was conceived by W. K. Hatt and later incorporated in the design of an apparatus with which to carry on the investigation. The original device provided for the inspection of only one specimen at a time, while the improvised machine allows four beams to be inspected simultaneously.

The machine consists mainly of a steel frame supporting test specimens, a motor and the essential working units. The principle of the application of the loads to the test specimens lies in the operation of an eccentric cam, which raises and lowers a load upon the ends of a horizontal straining member, supported in the center by a vertical test specimen. Four rocker arms, pivoted directly above the same number of test specimens, operate through a small angle by means of the cams rotated from a central line shaft. The U-shaped ends of the rocker arms fit around the cams. One end of a beam under test is clamped rigidly to the base of the steel frame and the upper end is clamped to the straining member. The operation of the machine subjects the outer fibers of the beam to alternate tension and compression at the rate of ten cycles per minute. A revolution counter attached to the machine indicates the actual number of reversals of stress for the separate beams.

Ten-inch Berry strain gages provided with Ames dials reading to 0.0001 in. are attached to both sides of the specimen, and observations of the total deformation from tension to compression are taken at designated intervals throughout the period of tests.

Test Specimens—The original specimens were 30 in. long and 4 by 4 in. in cross-section. It was found, however, that beams of uniform cross-section usually failed outside of the strain gage range near the lower support. In order to localize the failure within the strain gage points the cross-section, outside of the 10-in. gage length, was increased to 4 by 6 in.

Mortar specimens of a 1:2 mix have been used in the investigation up to the present time.

Strength of Specimens—Figure 1 illustrates the procedure used in determining the strength of the specimens. Duplicate test beams supported as in the fatigue machine are broken by the application of static loads in 10-lb. increments on one end of the straining beam. The strength factor as determined by the static-load breaks is considered as representative of the particular series of beams under question. In spite of all possible precaution observed in the construction of the test specimens, the maximum variation in strength from an average of six beams was about 15

per cent. It is appreciated that this variation creates a source of considerable error in the attempt to arrive at definite conclusions concerning fatigue of mortar.

Stanton Walker[1] has indicated that a relation exists between the modulus of elasticity and the compressive strength of concrete. The method of load application in the fatigue tests has accentuated an exhaustive study of the modulus of elasticity in tension of the mortar beams. An analysis of the data on hand indicates, however, that the modulus of elasticity bears to consistent relation to the transverse strength which might be used to advantage in more accurately determining the strength of the individual specimens.

Discussion of Tests.—The curve shown in Fig. 2 illustrates the typical effect of reversed stresses which caused failure of the mortar specimen. It is to be noted that there is a progressive deformation in the extreme fibers until failure of the test specimen takes place. A straight line of constant slope relation is indicated up to 110,000 reversals of stress. At this point, four cracks appeared on the outermost fibers of the specimen, and the slope of the line changed. An additional 35,000 reversals of stress were necessary to produce complete failure. The critical point in the progressive deformation cycle is designated as the premature failure limit.

The curve is representative of the tests completed to date, although in many cases the premature failure limit is not so pronounced and the additional number of reversals necessary for complete failure is less. A parallel cycle of action is indicated, nevertheless, by the general trend of the deformation curves.

It is apparent that rupture or failure of the bond occurs first on the extreme outer fibers where the deformation is a maximum. This action is progressive toward the center of the beam until complete failure is imminent. Continual progressive deformation of the outer fibers is significant of the fatigue element. Progressive deformation may occur in some cases for a certain number of reversals when it becomes evident from the flatness of the deformation curve that the material is showing no ill effects from repetitions of the load. The assumption is made that loads producing constant deformation are below the endurance limit or the safe working stress of the material.

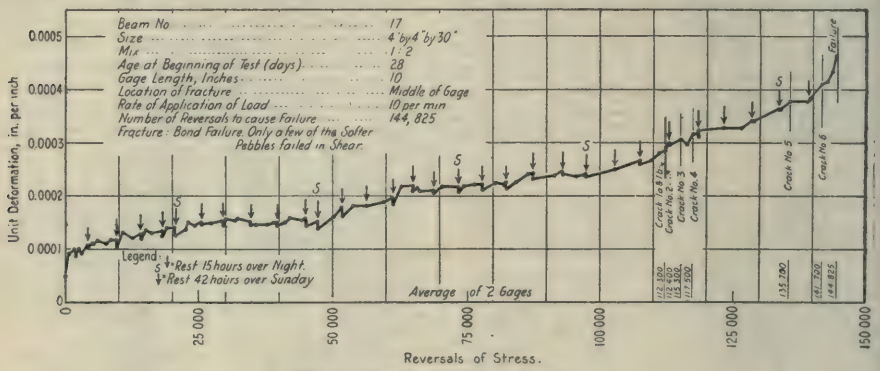


Fig. 2.—Typical Fatigue Curve.

Recovery Phenomenon During a Period of Rest.—An interesting feature of the fatigue tests, shown in Fig. 2 is that of the appreciable recovery during a period of rest of the strength of mortar undergoing a fatiguing action. It has been necessary each night to stop the machine and, as a result, the strength recovery phenomenon is clearly illustrated on the curve. A parallel action is common to many materials, such as, metals, wood and soils when they are stressed beyond a safe limit. The amount of recovery in the case of cement mortar is directly proportional to the duration of the period of rest. It is to be noted that no recovery occurs after the premature failure limit has been attained.

Fig. 3 illustrates some peculiar as

[1]Stanton Walker, "Modulus of Elasticity of Concrete," Proceedings, Am. Soc. Testing Mats., Vol. XIX, Part II, p. 510 (1919).

well as interesting features of a series of beams under test at the present time. During this series of tests it became necessary to stop the machine for five weeks, and as a result the effects of a prolonged rest period is clearly evident from the trend of the deformation curves. The beneficial or strengthening effect of the rest period is the most pronounced in the case of the specimen represented by curve D. In this instance it is believed that the induced stress approached the critical limit and that failure was imminent. The degree of deformation following the rest period indicates that the beam had fully recovered from the initial over-stressings. As these beams were five months old, it is thought that the increase in strength due to age over the rest period exerted a minor influence upon the subsequent resistance of the mortar.

This phenomenon seems to indicate that the rate or number of intermittent applications of load ranging in intensity above the endurance limit would have considerable bearing upon the life of the concrete structure.

It is to be noted that the effect of the rest period is less pronounced in the case of the specimens represented by curves E, F and G. In these beams, however, the induced stresses were apparently below the endurance limit and no fatiguing action had taken place. The general trend of the deformation curves after 140,000 reversals seems to be in a downward direction. As previously stated, it is believed that the influence of the increase in strength due to age is negligible, although the prevailing humidity and summer temperatures may have accentuated the apparent increasing resistance of the mortar.

Fig. 4 shows the sequence of deformation and the plastic set or failure of the mortar to return to its original position in both tension and compression. A marked contrast can readily be detected in the magnitude of the plastic set occurring at 18,800 and 23,760 reversals of stress, respectively. The broken line appearing in the cycle curve at 23,760 reversals shows the unit deformation after the beam had rested for a period of 16 hours. These maximum deformations are less than those of the same beam just previous to the rest period, which shows a partial recovery from the fatigue action. This action is typical of all tests in that progressive plastic set simultaneously accompanies fatigue.

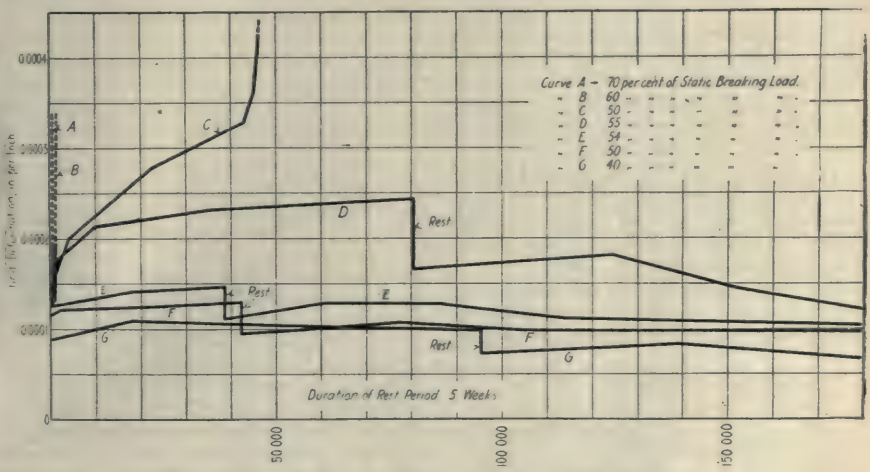


Fig. 3.—Curves Showing Effect of Prolonged Rest Period.

Indications and Summary of Tests.—The purpose of this paper has not been at present finished data or to draw definite conclusions concerning the fatigue of mortar and concrete, but more to stimulate interest and discussion of the subject. There are, however, several indications of prominence which are emphasized by this investigation:

1. (a) 28 Day Tests, 12 Beams, 1:2 Mix.—Results of this series of tests indicate that no definite endurance limit between 40 and 60 per cent of

that load required to break the beam under a single application can be assigned to cement mortar of this age.

(b) 4 Month Tests, 8 Beams, 1:2 Mix.—Results of this series of tests shown in Fig. 3 indicate that the endurance limit is approximately 50 to 55 per cent of the static load.

(c) 6 Month Tests, 6 Beams, 1:2 Mix.—Results of these tests shown in Fig. 5 indicate that the endurance limit is 54 to 55 per cent of the static breaking load.

2. The number of reversals of stress necessary to cause failure decreases in a proportion to the respective increase of the percentage of stress above the apparent endurance limit.

3. Stresses above the endurance limit cause continual progressive deformation.

4. Stresses below the endurance limit may cause progressive deformation within certain limits.

(In either 3 or 4, progressive deformation is not significant of permanent injury to the product unless actual rupture of the bond occurs on the extreme outermost fibers.)

5. The effect of a rest period indicates that the rate and number of intermittent applications of load ranging in intensity above the endurance limit would have considerable bearing upon the life of a concrete structure.

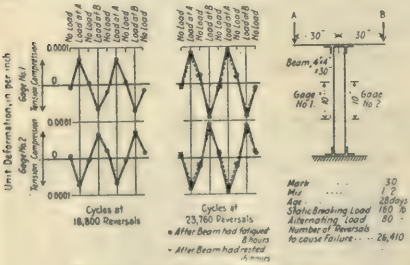


Fig. 4.—Typical Cycle Curves.

6. (a) The amount of recovery in strength in the case of cement mortar is directly proportional to the duration of the period of rest.

(b) Above the premature failure limit no appreciable recovery occurs.

Future Investigations.—The effect of rest periods upon the endurance or life of cement products will be carried on at a future date. In several of these series of tests, it is planned to subject beams to a limited number of reversals of critical stress every 24 hours, the stresses being maintained above the endurance limit. In other investigations it is planned to determine the endurance limit when the beams are not given these rest periods. Specimens of concrete as well as mortar will be studied in fatigue.

Authoritative results of the fatigue phenomena in mortar involve a time element of considerable magnitude and although these tests have been conducted during the past two years, this field of investigation is only opened. Certain features of the fatigue phenomena have already been indicated, and it is thought, from this foundation, that valuable information will be secured from future tests to aid in the proper design of concrete.

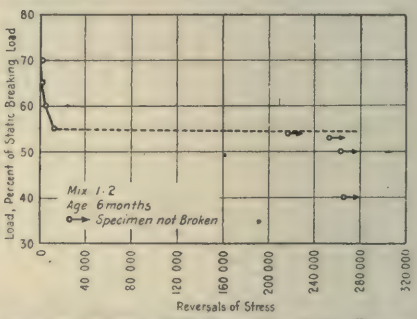


Fig. 5.—Fatigue Endurance Limit of Cement Mortar Beams.

Road Material Survey Being Made in Kentucky.—A survey of Kentucky to locate and map road building materials is now being made by Dr. Charles S. Richardson, head of the department of mineralogy, Syracuse University. The department of State Roads and Highways is co-operating with the State Geological Survey in carrying out the work. The survey probably will be completed in November, and the report published by Dr. Richardson. A recent survey of Kentucky by Dr. Richardson showed that there were 616 quarries in the State where building stones were produced.

Use of Automobile for Business Purposes.—According to estimates of the Illinois Highway Commission 35 per cent of the automobiles on Illinois roads are used for business purposes.

Gravel and Stone for Road Maintenance

Points in Preparation and Use in Indiana Practice Outlined in Paper Presented at 1923 Road School, Purdue University

By A. H. HINKLE
Superintendent of Maintenance, Indiana State Highway Commission.

(A) Gravel as used in road work might be classified as follows:
(1) Bank or bar run gravel.
(2) Screened or prepared gravel.
(3) Crushed gravel.

Bank or Bar Run Gravel—This is so variable that the term means but little except in a particular job or as it applies to a particular bar or pit. Many pits or bars furnish native mixed material which is very satisfactory for use in gravel road work. Where bank gravel is intended to be used the specification should be made accordingly—the object of the specification being to secure the best grade of bank gravel which it is practical to secure in that particular locality. It is poor practice to specify a bank gravel and then draw a specification that cannot be met by any gravel in the neighborhood.

Carelessness in writing a specification and then even greater carelessness in seeing that the specification is reasonably lived up to, has gotten many an engineer and contractor in trouble and occasionally the board of accounts is called in to "clear up the muss" and fix the responsibility for the specifications not being properly carried out. This carelessness in writing specifications and then the difficulty of getting them lived up to has encouraged, in some places, a specification which is in reality no specification at all. For instance, in one particular locality the only specification for gravel to be used in gravel roads and concrete work is, "It shall be a good cementing gravel." The specification might as well have said, "a good gravel" and stopped at that.

I will very frankly admit that it is not the easiest thing in the world to prepare a definite specification for each particular locality, which will secure the best local material which it is practical to secure. However, after sufficient study of the subject is made by the engineer, he can arrive at a proper specification. The State Highway Department of one of the states, just a few years ago, found it so difficult in attempting to apply the same specification to every community, that one of their representatives in explaining their troubles said that they finally became discouraged and threw away the specifications entirely and used such gravel as was available in each particular community.

The specification should be definite enough that a good contractor would ordinarily know whether bank run or prepared gravel would be required. If it is impracticable to secure the gravel specified, greater care should be taken thereafter in preparing the specification. A practice which should be of assistance would consist in submitting to a laboratory, for a test, samples of the local gravels which it is believed would be satisfactory for the road work, and then prepare a specification according to this test which would permit these gravels to be used. In this way the poorer local gravels would be eliminated and the best local gravels allowed.

Owing to the small cost of the little equipment needed to make a screen test on gravel and the ease with which this test can be made, every county should be equipped to make this test. Quite frequently the governing factor will be the percentage of gravel which will pass ¼-in. circular opening or a No. 8 or No. 10 mesh sieve. With a little pair of scales and screen and two buckets, one can make this test in the field quite as well as in the laboratory.

The gravel banks and bars of Indiana, are almost universally found with an excess of sand. Owing to this fact quite frequently a roadbed can be built up of the local material, and thereafter the wearing course put on and replenished by using a better grade of gravel or stone from the commercial plants. In this way a properly sized and good quality of material is furnished as a wearing surface and a large initial cost saved by using the bulk of the cheaper material for a foundation which of course will not be as good as the better grade of material which might be shipped, but which may be as good as the traffic

and finances available will justify using.

Screened or Prepared Gravel.—This is quite as variable in its make-up as is the bank or bar run gravel. The product from any plant naturally depends upon the native supply and the degree of screening and washing that is done.

Dry screening is satisfactory to take out the over-size gravel but it is seldom satisfactory to take out the fine sand because of the difficulty of the fine screens clogging. Even the shaker and vibrator screens apparently are not proving satisfactory for dry screening gravel. While a dry screening plant will work in a very few exceedingly clean gravels where the sand and gravel particles are exceedingly hard and are almost totally free from clay and silt, such ideal conditions for its use are seldom found.

A washing plant whereby the silt and clay are removed from the gravel by streams or sprays of water and the gravel and sand sorted by screens aided by the flowing water, is usually the most practical method of cleaning and sorting gravel and sand.

To make clean aggregate for concrete the washing is a necessity in most plants. However, while the coating of the pebbles and sand grains with silt or clay is objectionable when same are to be used in concrete, it is not objectionable where the gravel is to be used in a gravel road. On the other hand it is a real advantage provided, of course, there is not an excess of the silt or clay. Hence if it were practical to secure the dry screened material for gravel roads, it would frequently be more desirable than the washed material.

Owing to the great variety of material than can be furnished by different gravel plants, it may be necessary to vary the specifications in cases to accommodate the product from the various plants. It is quite easy to say that a definite specification should be prepared and universally used. Although a certain specification may produce best results on the road, it may be economy in many cases to depart from this specification, if you are going to pay dearly for using it.

Crushed Gravel—Prepared gravel made by crushing the over-size boulders in the gravel makes a product superior to uncrushed gravel for road maintenance purposes. The mixture of any amount of the crushed gravel with the uncrushed gravel aids it in compacting. A mixture of ½ crushed and ½ uncrushed gravel is quite frequently used and produces a very good material.

Sizes of Gravel.—The maximum sizes of gravel which it is desirable to use for various purposes may be listed as follows:

Sub-base course	6 -in.
Base course	2½-in.
Top course not less than 4-in. deep	1½-in.
Future maintenance	1¼-in. to 1 -in.

If the gravel runs exceedingly fine as it usually does in the Indiana pits, a 1½-in. maximum size for maintenance may be used very satisfactorily; however, if the gravel runs coarse or crushed gravel is used, 1¼-in. or 1-in. should be the maximum size used for general maintenance purposes. Much trouble and annoyance has been caused by the use of too large a maximum size of aggregate in the maintenance of gravel roads. The large sizes do not permit the drag to smooth up the surface so well as when the finer sizes are used, and the surface is inclined to wear rough and uneven more rapidly with the coarse gravels in the surafce.

The minimum sizes that might be used are preferably not to exceed 40% through ¼-in. and 10% through a No. 10 screen and 5% through a No. 30 screen; although gravels containing as high as 60% through a ¼-in., 18% through No. 10 and 8% through a No. 30 screen are used frequently with very good results. The most objectionable material is the excess of very fine sand and even material practically all passing the ¼-in. with not to exceed 18% through No. 10 and 8% through No. 30 screen, can be used as a skim coat in the maintenance of a gravel road with very fair results if the traffic is light. This brings us down almost to the sand-clay roads which give very fair results under light traffic, but which ravel quite badly during the dry season and cut up quite badly during the thaws, where heavy traffic comes on them.

It will thus be seen that the excess of very fine sand is the most objectionable part of many gravels and if this is controlled and the over-size gravel eliminated, we can allow a very large variation in the grading of the internal sizes and still get a very good gravel road. While a gradation

of the gravel and sand grains from the largest to the smallest is desirable, especially where a heavy coat of gravel is placed, as this gradation makes a dense mixture and aids materially in compacting the gravel, yet this requirement may be sacrificed to a very large degree if we eliminate the over-size gravel and the excess fine sand, for these two latter requirements are the most essential.

It must ever be remembered that the expense which we are justified in creating in specifying a better and more expensive grade of material, depends upon the amount of traffic we are serving. Certain places in the State the local gravel is of such poor abrasion value that we find one yard of good gravel or stone which has to be shipped, is equal to 2 to 3 yd. of local material, besides the better grade of material produces much less dust during the dry season and much less mud and slop during the thawing. Hence the use of the better material in these particular places, secures results which may far outweigh the additional cost where sufficient traffic is served. However, one should not be caught shipping material long distances and hauling at great expense to build a road when a local material practically as good may be found near by. A departure from this economic law in road maintenance has frequently started the taxpayers grumbling.

To determine which of such materials to use is one of the responsibilities of the road official whoever he may be. We will find much ground for a difference of opinion frequently, but if our knowledge is based upon sufficient observation and investigations, these opinions would not so frequently be at variance.

Crushed Stone.—Crushed or broken stone has been used in the building and maintenance of roads for centuries. The method of its preparation might be classified as follows:

(1) Hand broken.

(2) By local (small portable) crushers.

(3) By large commercial plants.

Hand Broken Stone.—For road surfaces and maintenance has almost entirely disappeared from use in this country. It is still quite extensively used in some of the foreign countries, especially the less civilized countries where the development of machinery has not progressed as in the United States. However, the hand breaking method is still used to some small extent in this State and in the hill portions of the country in general where small quantities of local stone are used for building and repairing light traveled roads. In such places shipping facilities are not available and it might not be economical to import a crusher owing to the small amount of stone that is used in any one place.

We have found it practical to use this method ourselves in a few cases in filling holes with local stone and in one case we have several miles of foundation stone which was broken with sledges after the stone was laid on the road. In new country where out-crops of good quality of limestone prevail at the roadside, this method no doubt will still be continued in use in building road foundations, as the large stone can be laid cheaply and only a very limited amount of sledging is required. Where limestone out-crops in the vicinity of the road and it becomes necessary to plug up breaks or mud holes in the road, I know of no more effective way to make a stable foundation hurriedly while the road is carrying traffic than by "sledging in" the large pieces of stone gathered from the field or local quarry. This coarse foundation stone must of course be covered with fine stone, preferably of two sizes, the last coat not exceeding 1-in. in size.

Hand breaking caters more to the use of a coarser stone in the foundation which is exceedingly desirable, for if any great mistake has been made in modern road building to take care of the heavy traffic of today, it is in the use of too finely crushed stone for macadam foundation work. While hand breaking is a method of doing road work which in general belongs to past history, it is surprising to note how rapidly the process of breaking stone by hand can be done by an experienced bunch of laborers. Under special conditions such as these mentioned above, it will still be economical to use hand breaking in building foundations where it is not necessary to reduce the stone to a small size. However, for surfacing a road and maintenance work, the use of a modern stone crusher to prepare the stone is imperative.

Local (Small Portable) Crushers.—One of the advantages of the local or small portable crusher is that it can be transported to districts where

out-crops of limestone are available and the stone crushed near the roadside and thus one of the expensive features of all road work, namely, that of the long haul, is reduced to a minimum. The disadvantages of the local crushers are (a) That it is more expensive to produce stone with a small crusher than with a large crusher; (b) It is difficult to produce the sizes that are frequently desired and the sizes that are absolutely necessary for certain classes of first-class macadam work. Of course it must be understood that the local crusher is only practical where suitable stone is found in the local community and an expensive haul or freight rate is saved.

If a sufficient sized crusher and proper screening plant is installed, any desired size and grading of stone can be produced from a portable outfit. We must weigh the cost, however, of such production, against the cost of the shipped material. With a local plant there is also only a limited demand for any one grade of stone and more difficulty will usually be experienced in disposing of the off sizes than from a commercial plant with shipping facilities, where there is a wider range of market.

Large Commercial Plants.—Inasmuch as the bulk of the stone we use is prepared at the large commercial plants, it is dealing with their output that we are mostly concerned. Large commercial stone plants should be equipped to produce any size of stone, and stone with any degree of freedom from dust.

Perhaps one of the defects in many plants is that they are not made so that they are sufficiently adjustable to different conditions, that is, so that they can shift from one size of grading of stone to another size without an expensive operation. This lack of adjustability in the plant is frequently caused by the lack of sufficient study and consideration being given the details of the operation of the machinery in designing the plant. It is best that the superintendent of every stone plant and the mechanic who may have direct charge of the designing of the machinery, should have emphasized to him, the importance of being able to shift from one grade of material to another when the demand of the output of the quarry makes it necessary, instead of restoring to the expensive method of storing stone or sometimes, as has been done, in shutting down the plant because all of the product of the quarry cannot be disposed of.

I one time happened upon a piece of macadam work where the specification provided that the maximum size of stone should go through a 4-in. circular opening. Some of the stone that arrived on the job was so large that it was quite evident that it had not gone through a 4-in. circular opening. I called by long distance 'phone the stone company's office and they assured me, after calling the plant and talking to their superintendent, that the stone was going through a 4-in. screen. I told them that I would be down to the plant that afternoon. After making a 60-mile drive across country and arriving at the stone company's office, I was told that they had made a further investigation and that it was possible that the screen was a 4½-in. screen. We drove to the plant, which is several miles out in the country, and after going up some 70 ft. in the air and looking at the screen in operation, the superintendent agreed that it might be a 5-in. screen. I prevailed upon him to shut down the plant so that we could measure the size of holes whereupon we found that the screen was a standard 5½-in. screen and being an old screen badly worn in some places the openings in it measured as much as 5¾-in. across. My experience on numerous occasions of this kind has led me to believe that too frequently the manager of a plant and even the superintendent does not give enough attention to the details of the screening, which is so important a feature of stone production in the preparation of stone for the building of the higher types of road.

Overloading of Screens.—It is not uncommon to see stone coming in from a screen with 20 to 50 per cent of the material that would readily go through the openings in the screen over which it passes. This is usually due to the overloading of the screen. While the angle of the screen, size of openings and rate of revolution of a screen determines the amount of "fines" left in the product, yet every screen has a capacity, which, if exceeded, will greatly increase the amount of undersized stone left in the product. Sufficient screen capacity is just as important a part of the plant as crusher capacity.

Removal of Dust and Clay from Small Size Stone.—While use of the

revolving circular screen is almost universal in stone producing plants, the separation of the dust from the finer sizes of material where it is imperative that those sizes be free and clean from dust, is now being done quite extensively by shaker and vibrator screens which perhaps clean the material better than by any other process. The ease with which the dust and fine material is removed from crushed stone depends very largely upon: (a) The percentage of clay that it permitted to go into the crusher and mix with the stone; (b) the moisture in the stone and clay; and (c) the hardness of the stone. It is very difficult to eliminate clay from the fine stone when it is damp as happens during a rain on the quarry, and when the clay has been put into the crusher with the stone. Where it is imperative to produce clean stone, as when the stone is used in concrete and bituminous roads, it is very imperative that great pains be used in stripping the quarry. During periods right after a rain if a little care is used in filling the cars in the quarry, frequently the freedom of the finer stone from clay will be very favorably affected. It is not uncommon to happen in a quarry after a rain in small plants where hand loading is done, and find the shovelers scooping up dirt, clay, stone and all into the small dump cars. One thing we can positively state is that if clay does not go into the crusher it will not come out in the fine stone. The harder and flintier stones naturally produce a cleaner, small size product than the softer stones.

Sizes of Aggregate for Various Purposes.—There is such a large variety of sizes of aggregate used for various purposes, that it would almost make one dizzy to enumerate all of them. For this reason a number of years ago an attempt was made to standardize on the size of aggregates. This was done fairly satisfactorily. However, it seems that owing to the fact that difference in various city, county and state specifications and the different ideas of various stone crushing companies as to what size they should make, has caused us not to make much progress in this standardization of sizes. It is a fact, too, however, which must be taken into consideration, that stones of different hardness will permit the use of a little different size; that is, generally speaking, in macadam work the harder the stone the smaller should be the maximum size used for any particular purpose.

A general principle in the sizing of stone for macadam work might be to use as coarse a stone as can be used without causing an objectionable roughness of the particular type of surface in which the stone is used. The thickness of the surface course may determine the maximum size that can be used; that is, within certain limits a thin course will require the use of smaller size stone than a thick course. As a general guide the following might be taken as a limitation of sizes for various purposes:

Waterbound Macadam Top Course.

(a) If surface is to be maintained in the future by the applying of fine stone and dragging, 1½-in. to ¾-in. size.

(b) If surface is to be maintained in the future with the use of bituminous surface treatments, 3½-in. to 2½-in. 1-in. to dust for soft stone.

(c) For filler ¾-in. to dust for medium stone; ½-in. to dust for very hard stone.

Bituminous Macadam.

(a) Covering stone for first application of tar or asphalt, 1¼-in. to ¾-in. size.

(b) Covering stone for last application of tar or asphalt, ¾-in. to ¼-in. size.

Bituminous Surface Treatments of Tar or Asphalt.

(a) Treatments ⅛-gal. per square yard, ½-in. to ⅛-in. size.

(b) Treatments ¼-gal. per square yard, ¾-in. to ¼-in. size.

(c) Treatments 2-5-gal. per square yard, 1-in. to ½-in. size.

Stone road maintained with light covering of stone and dragging operations:

(a) Very light application of stone—Hard stone, ⅝-in. to ¼-in. size; medium, 1-in. to ¼-in. size; soft stone, 1¼-in. to ¼-in. size.

(b) Heavy application of stone—1½-in. maximum size may be used, preferably to be covered with one of the above sizes.

Cold Bituminous Mix for Patching.

(a) To be put down with a roller or under very heavy traffic, 1½-in. to ¼-in.

(b) To be put down by hand tamping, ¾-in. to ¼-in.

While the above tabulated sizes are more or less the ideal sizes, quite a

variation from these can be permitted in some cases, and yet first-class results be secured. In fact there may be certain conditions where a departure from these sizes would be desired. For instance: Where a comparatively soft stone is used in bituminous and waterbound macadam to be later maintained by surface treatment, the larger size stone might better be a maximum size that will go through a 4-in. circular opening instead of a 3½-in.

While for foundation stone, in order to accommodate the quarry, frequently 2-in. or smaller stone has been used, it undoubtedly would be better to use a much coarser stone, even as large as would go through a 6-in. opening, if the stone is to be rolled and waterbound.

Wise Location of Gravel and Stone Plants Necessary.—Proper selection of quarry sites and location of gravel plants both for the local plants and large commercial plants, is very important. Before capital is invested in such a plant, the gravel and stone should be tested for all depths and areas over which it is contemplated to develop the plant. Capital cannot be wisely invested unless this is done. Too frequently a quarry or gravel plant has been located only because it was considered an economical place to strip the stone or gravel. The saving in this respect in a particular location may be only a very small part of the cost of production which small saving might have been counteracted several times by the better quality of stone or gravel at some other location. One thing is certain, that if the quality of stone or gravel is not present to start with, a good product cannot be produced. In many places a plant would not have been opened up at all had sufficient examination been made. A plant that can economically produce good gravel or good stone is an asset to the state and the taxpayers profit thereby. A plant that produces poor grade material and does not operate economically is a disturbing factor to good society. A poor grade stone can frequently be produced cheaper per ton than a good hard stone. This cheaper cost of production is too frequently used in maintaining a big lobby to force the sale of the poorer grade material to the road officials. In such cases the road official needs our sympathy. Here is where a laboratory test on the material may come to your relief. The good material sells itself and only necessitates a large promotional expense when the other fellow gets the best of the situation. Let us hope that everything possible will be done to overcome the overpromotion of poorer grades of material and material that is not economical to use. We can assist in this somewhat by being fair to the legitimate commercial plants which produce good material. Much capital is invested in them. They are an asset to the state and should be encouraged. We should not encourage the establishment of local plants because these can produce material about as cheaply on the road. The local plants should be encouraged only when beyond a doubt they can produce material on the road cheaper than the commercial plants, taking into consideration the quality of the material. The commercial plants have been hit an awful blow the past few years because of the unstable situation of our railroads and some of them will need nursing if they survive another similar condition. However, the economic law of production of road materials must prevail and if this fluctuating condition of our railroads is to continue in the future, the shipping of road material will have to harmonize with it.

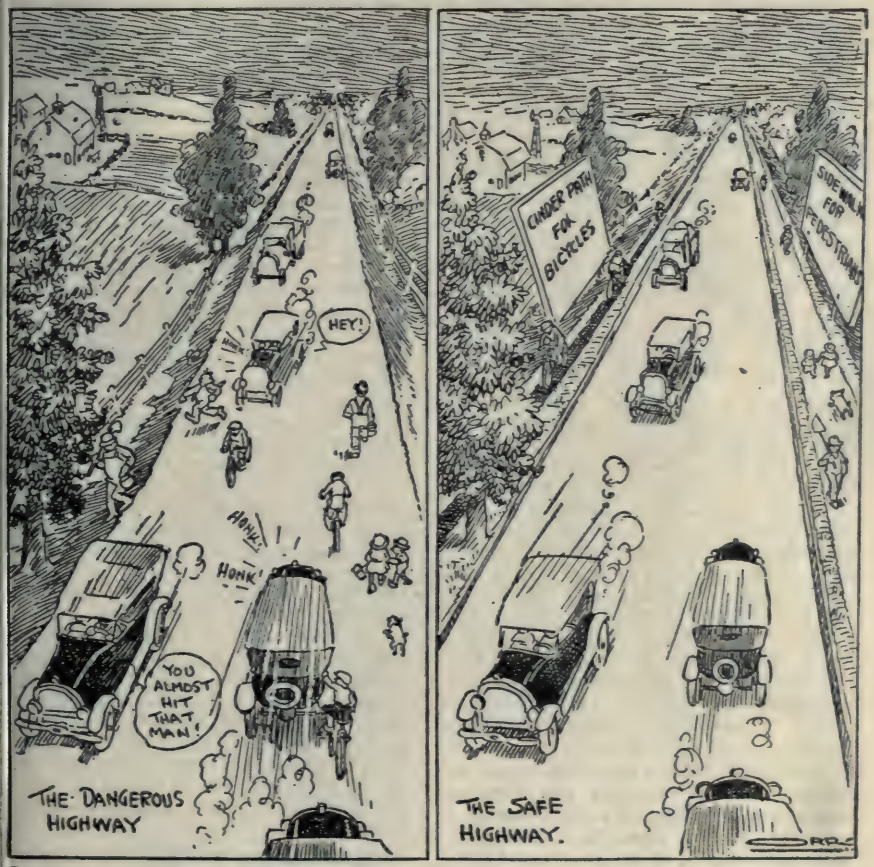
Talent Needed in Manufacture of Road Materials.—Although the road material producers, and we in the road maintenance and construction work, may feel too proud and bigoted to admit our work is not being done to the maximum efficiency, we will have to admit as part truth the statement some one has made, namely, "The brains of the world is now employed in the automotive industry!" This industry has paid bigger salaries and has offered greater inducement to our young men than the road work. Let us hope that we may stem the tide eventually, and direct back into the channels of road production some of the talent that has been going into the automotive industry. The advance that this industry has made over road production is too great. The road work should keep abreast, if not a few years ahead, of the industry which wears out the roads. The public must be made to see the truth. It is not consistent that an automobile owner should pay 12 ct. for operation expense for every mile he drives his car, and then object to paying 2 ct. gasoline tax which on an average

amounts to 1.6 ct. per mile, in order to have good roads over which to operate the car. Any man who continues to study any subject and has a reasonable education, eventually becomes more or less of an expert in that subject. Certainly with more talent directed into the production of road materials, and doing road maintenance and road construction work the industry would be benefited.

Test Road in Kentucky.—The Kentucky State Highway Department is to build a 1-mile test road, divided into a number of sections, each built under a separate specification. Local material will be used on a majority of the sections.

Forest Road and Trail Construction.—During the calendar year 1922 the amount of Federal funds spent on highways by the United States Department of Agriculture totaled $5,603,100, which constructed 2,420 miles of forest roads and 4,190 miles of forest trails. An additional $950,000 was secured for this construction work from State and county authorities. During this same year 4,550 miles of roads and 19,600 miles of trails were maintained at a cost of $500,000.

Effect of Center Lines on Traffic Safety.—The National Highway Traffic Association estimates that a center line on a highway increases its safety from 25 per cent to 50 per cent.



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A Safety Suggestion for Highway Construction.

Progressive Construction of Highways

Practice in Iowa and North Carolina Described in Papers Presente at 20th Annual Convention of American Road Builders' Association

Practice in Iowa

By C. COYKENDALL,
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No single problem is provocative of more difference of opinion than that of the proper policy for the development of a highway transportation system. Nor is it surprising that such should be the case, for there is no one proper solution to the problem. Obviously, the proper solution of Rhode Island's highway problem will not apply equally well to the highway problems arising in Texas, nor can a solution that is proving effective in Pennsylvania be unqualifiedly recommended for Wyoming. The problems arising in connection with the building of a system of highways are manifold, and fortunate indeed is the state which has highway laws flexible enough to fit all conditions within the state, and officials in charge of highway work possesesd of sufficient vision, courage and authority to apply the proper solution to the various problems confronting them. If such a state there be, let it be known, in order that the lawmakers and highway officials of other states may journey thence and become enlightened.

Iowa's road building problems are not exactly duplicated elsewhere. The state has 56,000 square miles in area and more than 104,000 miles of rural highway, with practically every one of these miles, to a greater or less degree, an essential part of the state's highway transportation system. Every section of the state is productive, and consequently is inhabited. Excluding the population resident in cities and towns, it is found that the density of rural population is remarkably uniform throughout the state, with a correspondingly uniform need for a usable system of rural highways throughout the state.

Traffic on Iowa Highways.—Let us consider for a moment the sources and kinds of traffic that the roads of Iowa are called upon to carry. The surplus products of all sections of the state must be hauled over rural highways to the shipping and market points, and from these same shippin and market points, coal, machiner lumber and other materials and su plies must be hauled back to the farn Heavy tractors for operating threshin machines, corn shellers and silo fil ers must be able to move from far to farm, and for this purpose, su stantial bridges are necessary. A co stantly increasing percentage of th children of the state are being ed cated in modern, consolidated school and the school busses in which thes children ride to and from school 9 every 12 months of the year, mu have safe and usable roads an bridges over which to travel. In thos sections of the state within a radiu of 50 miles of great meat packing ce ters such as Sioux City, Omaha an Nebraska City, it is found highly ec nomical to market livestock by truc instead of train, as it is found th the increased transportation cost b truck haulage is much more than o set by the small shrinkage in weig of the live stock hauled by truck, a compared to the shrinkage whe hauled by train. In the vicinity all considerable centers of populatio slow and costly railway and expre service is being supplemented by m tor transport. Two of the nation best marked and most widely-know transcontinental highways, and mar other important but less widely-know interstate highways, cross the stat Yearly the interstate traffic on thes highways is increasing. Traffic coun taken during the past season at point east of Ames, where for a sho distance the Lincoln Highway and th Jefferson Highway use the same roa show that of a total average dai traffic amounting to 1,036 vehicles, 1 vehicles, or 14.3 per cent of the tot traffic, was motor cars with foreig licenses. And last but by no mea least, the 500,000 motor cars owne in Iowa are decidedly active orga isms, penetrating every nook and co ner of the state, on business or plea ure bent, and requiring roads—usab roads.

Highway Construction Has Lagge Behind Traffic Development.—Fro the foregoing, it will be seen that th

various classes of roads in Iowa are called upon to carry almost every known variety of modern highway traffic, and the suddenness with which most of this traffic has developed is the element that makes the problem of providing adequate highways so stupendous. If the development of highways in Iowa during the past decade were to have kept pace with the development of traffic using those highways, there should have been constructed during that time at least 2,500 miles of paved road, at least 25,000 miles of graveled or similarly surfaced roads, another 25,000 miles graded and drained, and the remaining mileage maintained in usable condition and safely bridged. Such a program of improvement would have cost approximately $500,000,000, whereas the actual total highway expenditures during this period amounted to approximately $195,000,000, or 39 per cent of what would have been necessary had highway improvements kept pace with the development of highway traffic.

On the other hand, during the same period of time the people of Iowa have invested more than $750,000,000 in automobiles, thus showing a much greater liberality in the financing of privately owned rolling stock than in the financing of publicly owned road beds.

Iowa's Highway Policies Always Conservative.—In most respects the citizens of Iowa are conservative Having no great centers of population, her policies as a state are formulated largely by the people of the rural communities—people whose personal prosperity has resulted from conservatism in their personal affairs and who naturally are wont to apply the same policies to public affairs. Logically enough, therefore, Iowa's highway policies have always been conservative. Until 1904, Iowa as a state took no part whatever in road building activities. All such work was under the supervision of county and township officials. Bridges of 16 ft. span or more were known as county bridges and were built and maintained by the county. In addition to this, county boards of supervisors had authority to levy a small tax, known as the county road tax, the proceeds from which could be spent on road work by the county supervisors at their own discretion as to location and type of improvement. As the condition of roads and bridges was a matter almost wholly of local concern, logically enough the administration of highway matters had remained vested in local officials.

About 20 years ago, when it first began to occur to some of the more forward-looking that the existing method of handling matters pertaining to roads and bridges might not be all that could be desired, it was natural that bridges and culverts received first consideration. Travelers on the roads at that time could usually choose favorable weather conditions for making their trips, but the bridges and culverts had to be crossed. Further, about this time the heavy steam tractor was coming into more general use and was playing more or less havoc with flimsy bridges. Naturally the owners of these tractors wanted better and safer bridges built, and these same owners, though their state threshermen's association, later proved to be one of the most effective agencies in securing progressive road legislation.

Early Work of State Highway Commission—The state highway commission, created by legislative enactment in 1904, was vested with only advisory powers. Such counties as desired could avail themselves of the commission's engineering services and advice, although there was nothing obligatory that such advice must be followed. Accomplishments during the period that this system was effective—1904 to 1912, inclusive—were entirely along the line of progressive construction. A large number of counties commenced building bridges and culverts of permanent construction and cutting down hills and filling hollows adjacent thereto. Toward the close of this period the use of large blade graders drawn by gasoline tractors became quite general, resulting in the building of a considerable mileage of dirt roads to a natural grade, and to sections closely approaching present day standards. Very little surfacing work of any kind was undertaken except for short stretches of gravel surfacing here and there in progressive communities where an abundance of local gravel was available.

The Highway Legislation of 1913.—In the spring of 1913, radical highway legislation was enacted by the state legislature, which resulted in a complete change in the method of handling highway work. This legislation reorganized the state highway commission, clothing it with drastic supervisory

powers, and providing adequate funds for its support. Under this statute the state continued its policy of non-participation in the cost of road building, but required all highway construction work, both road and bridge, to be done in accordance with plans and specifications either prepared by or approved by the state highway commission. Other outstanding features of this legislation were the requiring of each county to employ a county engineer to supervise road and bridge construction work, and the classification of highways into a county system and a township system, the former being placed entirely under the supervision of county officials, and the latter remaining under the jurisdiction of township officials, with the restriction that any construction work upon the township road system must be done in accordance with plans prepared by the county engineer and approved by the state highway commission.

Under this scheme of operation, real strides were made in the way of progressive road construction, particularly upon the county road system. By the end of 1916, approximately 1,600 miles had been built to established grade in accordance with approved plans; approximately 25,000 bridges and culverts had been constructed of so-called permanent construction; practically the entire mileage of the county road system—some 15,000 miles in all—had been constructed to natural grade and standard section and was being rather systematically maintained; in fact, Iowa had acquired a reputation for having a remarkable system of dirt roads—remarkably good under favorable weather conditions and remarkably muddy during rainy weather. Still but little surfacing work had been undertaken, road building efforts and revenues as yet being devoted to the building of earth roads and substantial bridges and culverts, with here and there a few rather desultory attempts at gravel surfacing.

Results of Federal Participation.—The coming of federal participation in highway building necessitated further changes in Iowa's highway laws. Such changes were brought about during the legislative sessions of 1917 and 1919. A further classification of highways was made, a limited trunk line system of approximately 6,600 miles being designated as the Primary Road System, upon which all Federal Aid allotted to the state, as well as all revenues derived from the licensing of motor vehicles, must be expended. The remaining mileage of highways was classified as secondary roads, approximately 11,000 miles of which constitute the county road system, and the remaining 87,000 miles still being under the supervision of the township officials.

Improvements on Primary Road System.—Under this revised legislation the policy of progressive construction persists. The primary road fund—Federal Aid and revenues derived from the licensing of motor vehicles—is divided among the various counties of the state in proportion to their area, providing a fund of approximately $90,000 annually to the average county for improving and maintaining approximately 67 miles of primary road. Obviously this fund is not sufficient to make possible any considerable progress in building roads having a high type of surfacing, and except in those few counties that have taken advantage of a provision of the law which allows anticipation of future allotments of primary road funds through the issuance of county bonds, the improvements undertaken on the primary road system consist largely of completing the construction of roads to established grade, providing the necessary drainage and drainage structures, and when this has been completed, surfacing with gravel or sand-clay construction. In addition to the inadequacy of funds heretofore mentioned as restrictive to a paving program, the law imposes further restrictions in requiring the question as to wether or not the primary roads of a county shall be hard surfaced to be submitted to a vote of the people of the county. The further provision that when hard surfacing is authorized, 25 per cent of the cost thereof is assessed to abutting and adjacent property, acts as an additional deterrent in getting a hard surfacing program under way.

Accomplishments toward the improvement of the primary road system since its establishment are therefore largely along the line of progressive construction. On Dec. 1, 1922, of the 3,653.5 miles of the primary road system that had been constructed to established grade and the necessary drainage and drainage structures provided, 334.4 miles had been paved and 1,558 miles had been gravel surfaced, leaving 1,761.1 miles without surfacing of any kind. A large percentage

of the mileage that has been gravel surfaced will need to be paved some time within the next decade if traffic is to be adequately served. In the meantime, however, traffic on these 1,558 miles of gravel surfaced highways is getting reasonably efficient highway service, whereas the same funds invested in pavement would have given traffic a high grade of highway service on only approximately 150 miles.

It will thus be seen that up to the present time road building in Iowa has been hedged about with restrictions that make any policy other than that of progressive construction, entirely impractical. Neither is it believed that Iowa is the loser on that account, nor that the opposite policy of highway improvement; that is, the concentration of available highway revenues upon a limited mileage of high type roads, would have given traffic upon the highways in Iowa a service comparable to the service that has been given. The dirt roads that have been constructed to established grade and the necessary drainage and drainage structures provided, give vastly better service than do the ungraded, undrained and poorly bridged highways. Also, the highway that has been graded several years in advance of the time that it is to be hard surfaced is in much better condition for hard surfacing than is a newly graded highway, particularly so in locations where the topography is rolling. To hold to 6 per cent maximum grades on some primary roads in Iowa requires upward of 30,000 cubic yards of earthwork per mile. Experience teaches that the resulting fills under these conditions require two or three years to become stabilized and that a rigid type of surfacing should not be attempted on these fills until they have become thoroughly stabilized.

In conclusion, it may be said that the policy of progressive construction of highways in Iowa is a logical result of its traffic needs and its highway laws, which after all are in a measure reflective of traffic needs. Under this policy, substantial progress has been made. If highway traffic is to be given anything like the service it deserves, however, there must be no undue hesitation about taking the succeeding steps so necessary to the success of such a policy. Based on present costs, at least $100,000,000 must be spent during the next five years on constructing and maintaining the primary road system alone, if traffic is to be only reasonably well served. An equally large expenditure should be made during that period on secondary highways. It is not a case of the state not being able to afford such expenditures; rather it is a case of the state not being able to afford to do without the highway service that will result from such expenditures.

Practice in North Carolina

By C. M. UPHAM,
State Highway Engineer of North Carolina.

If a state had an unlimited supply of money it would be a simple problem to construct a state highway system, but practically all states are limited in the amount of money they have to spend in the construction of their road systems.

The function of a state highway commission is to provide a means of transportation for the state, and not the mere building of a few miles of hard surface roads and bridges at a few selected places throughout the state. For a state to develop as a whole, it is necessary that a connected system of highways should be available for the purpose of providing a means of transportation for the state's development.

Traffic is concerned with the roadway only to the extent of being provided with a smooth highway over which it may travel at a minimum of operation cost. The selection of the type of highway to construct is the problem of the engineer, after due consideration of all affecting elements, and should be a highway which will adequately and efficiently carry the traffic at a minimum maintenance expense.

It is absolutely essential that the road should be selected and so constructed that the money invested in the system of highways will at all times be a minimum. To best do this, means the construction of progressive type roads, in which all the standards of construction are the same, and by the use of which the lighter traffic is provided with a road suitable to its needs, and the heavier traffic with a hard surface road, which is the ultimate surface of all progressive type roads.

Method of Solution Differs in Different States.—The solution of providing a means for traffic or the construction of a highway system in every

state necessarily depends upon the local conditions in that state, and consequently, the method of solution will be different in the different states and depends on the economic, industrial, and social conditions throughout the state.

Practically every state in the Union has its cities and counties of high and intensive development, as well as its sparsely developed sections. To build immediately a system of hard surface roads throughout an entire state, when the demands for such roads are only within the highly developed sections, would be money wantonly wasted.

Within the highly developed sections, no doubt the construction of a hard surface pavement is the correct and only answer. In the urban and outlying districts, where the traffic is less intense, a lighter and less expensive road may adequately serve the needs of traffic. This less expensive road should be located, graded and drained upon the same standards customary with hard surface construction, so that when the country through which the road passes develops to the extent that traffic requires a heavy duty road, there will only be the necessity of adding the hard surface in order to adequately provide for the heavy traffic which may at some future time make demands on this highway. Still farther from the highly developed centers, and far out into the less developed country, there are still lesser traffic demands. Few vehicles and light loads generally constitute the pioneers in transportation. Quite often graded roads, with the proper drainage structures, constructed upon hard surface standards, will suitably take care of this rural traffic.

After the construction of the graded road provides a means of development, and the traffic demands become greater, a higher type surface, possibly a sand-clay, topsoil or gravel, can be added to the previously graded road, and when the locality still grows and the sections become more highly developed and the traffic demands are greater, there only remains for the road builder to surface these progressive roads with a hard surface. This will efficiently provide for the heavy traffic, which ultimately makes demands on the roads in the developed localities.

Conditions in North Carolina.—North Carolina has three distinct geographical divisions. The mountain section is made up of farming and mining sections with numerous resorts so located as to take advantage of the wonderful scenery; the piedmont section or foothills, with its farms and industries highly developed; and the flat coastal plain, with its excellent farms and industries claiming great attention for their transportation needs. These three great geographical divisions are divided into one hundred counties, and many more centers of population. It is the work of the state highway commission to connect these centers with a highway system or a means of transportation which will adequately provide for the class of traffic which now exists and is expected in the near future. The problem of selecting the type of progressive road is somewhat reduced when it is seen that hard surface roads are immediately required to efficiently and economically care for traffic demands in connecting the developed industrial centers. This is also true in the highly developed farming sections. The remainder of the problem is to provide suitable and continuous roads to connect up the centers in a manner which will satisfactorily provide for the needs of transportation, at the same time keeping the money investment always at a minimum.

The distances are long and it is practically always the fact that the state's development and the intensity of traffic will not justify the construction of hard surface roads throughout the entire system. The answer to the problem of providing the state with a means of transportation lies in the construction of progressive type roads so constructed on high standards that they may be ultimately turned into hard surface roads by the addition of a higher type standard surface.

North Carolina Method.—The North Carolina method of progressive type construction is to grade the road, using the same standards for line and grade that are used in hard surface construction. Only one standard of drainage structures is used regardless of whether the road is merely graded or is to be covered with a hard surface. This construction of graded road will care for the light traffic which generally exists in all newly developed localities. This graded road is at all times maintained and when the increased traffic creates a high cost of maintenance, then it is indicated that it is time to construct the next higher type of road surface. The next step in the progressive type road is to cover the graded road with a selected

oil material, such as sand-clay, top-oil or gravel. This material is gen-rally of higher bearing value than he natural soil, and is a material hich is less affected by moisture and herefore more suitable for use as a oad surface. This selected surface aterial is maintained as a subgrade ighway until such time as the main-enance cost becomes excessive and he increased traffic indicates that a ard surface roadway is necessary.

The cost of grading and the drain-ge structures generally constitutes bout one-sixth of the ultimate cost of hard surface road. To add a select-d soil surface adds very little differ-nce to the cost of this construction; onsequently about six times as much oad, with a selected soil surface, may e constructed for the same money as hough the money was spent for the mmediate construction of hard sur-ace roads. This makes it possible for ransportation to be benefited to a uch greater extent and the state to levelop at six points rather than in ne.

It will be noted that the construc-ion of the selected soil surface is an ddition to the graded road, and no revious step in the grading or con-truction of drainage structures has een lost or thrown away in the con-truction of this selected soil surface oad.

In the progressive type road all teps taken in its construction include he utilization of all previous construc-ion when transforming the road to he next higher type, and each step nay be considered as a subgrade for he next higher type surface. This in tself justifies the expenditure of a ufficient amount of money to select oils of a character which may, with roper maintenance, be used as a sur-ace material until such a time as raffic demands, or the cost of mainte-nance makes it necessary to construct he next higher type of hard surface. By this method of construction the raded road or the selected soil sur-ace can truly be called a subgrade ighway, and is often the economic olution for road construction over a arge portion of a state system.

The Ultimate Step.—The ultimate tep in progressive type construction s the addition of the hard surface. After the maintenance on the selected oil surface becomes excessive or when the country and traffic develops to the extent that a hard surface road is nec-essary, the next step is to construct the hard surface pavement directly on the selected soil surface. This method of progressive construction utilizes advantageously the selected soil surface as a stabilized subgrade for the hard surface pavement, and on account of the complete settlement, and on account of the character of the selected soil surface, the subgrade is stabilized sufficiently to aid the hard surface in carrying the loads.

Therefore it may be seen that with the construction of the progressive type road, light traffic or a small tonnage is cared for by a graded road of comparatively low cost. As the traffic demands and tonnage increase, the road is increased in strength, and the increase of the investment is justified. As the traffic and tonnage increase to the maximum, a hard surface road is constructed. The construction of roads on progressive principles means that the greatest percentage of the invested money is in permanent construction, and justifies the expenditure of bond money in any progressive type road.

North Carolina has constructed many progressive type roads. It has already completed its cycle by placing hard surfaces on roads which were previously graded and stabilized with a selected soil material, although at present it has a reasonable mileage of graded roads in the newly developed localities; it is maintaining as subgrade highways a large mileage of selected soil roads and thus affording a means of traffic to a great portion of the state. The completion of about 400 miles of hard surface construction in 1922, many miles of which was hard surface, added to progressive type roads, demonstrates the complete and satisfactory manner in which the progressive road is carrying for the traffic in North Carolina and shows that this method of road construction is no longer in the experimetal stage, but that this means of constructing a highway system is economically and practically sound and is highly recommended where the geographical, industrial, social and economic conditions are as found in North Carolina.

Street Cleaning Officials to Meet at Chicago.—The annual conference of the International Association of Street Sanitation Officials will be held in Chicago on Sept. 27 and 28, with headquarters at the Hotel LaSalle. W. J. Galligan of the Bureau of Streets of Chicago is president of the association and A. M. Anderson, 10 South LaSalle St., Chicago, Ill., is secretary.

Street and Highway Lighting

Proper Illumination as a Means of Preventing Accidents Discussed in Paper Presented April 30 Before Allied Motor Commerce of Indiana

By CHARLES J. STAHL,
Manager Illuminating Engineering Bureau, The Westinghouse Companies.

Street lighting has had a fascinating development which up to about 20 years ago was impelled almost entirely by man's desire for safety, comfort and peace of mind. The fundamental motive was crime prevention. Today it is still the fundamental consideration but other motives have grown to be of almost equal importance. Briefly stated these other considerations are:

1. Accident prevention.
2. The "City Beautiful" idea.
3. Business stimulation.

Traffic Requirements and Lighting.—I am mentioning this to show that up to recent times the requirements of traffic were almost entirely neglected in the lighting of streets and as for highways what little has been done is hardly a beginning on the thousands of miles of intercity highways which along with the automobile have grown to such great importance in our national life. Fortunately the requirements of good street lighting from the standpoint of preventing crime are to quite an extent the requirements for safe and comfortable traffic, except that the latter requires higher intensities of lighting. But unfortunately no national or civic organizations have consistently advocated and fostered the use of ample and efficient street lighting.

Our first thought is that the electric light companies should be its advocate, but they unfortunately are very often forced to enter into contracts in which the rates allow no profit and not infrequently the street lighting business is actually taken at a loss to the electric light company supplying the power. Naturally they make no effort to increase unprofitable business.

For its value as a business stimulator merchants have here and there fostered local improvements but no highway association, or other allied societies, have so far undertaken extensive propaganda or educational work on the value of good street and highway lighting which in comparison with most other public services is high in proportion to its cost.

Street Traffic Accidents Due to Automobiles.—The time has come when in connection with our street lighting we must recognize that we have entirely different problems to face than ten or even five years ago, and the cause is the automobile. To the development of modern high speed traffic brought about by its extensive use must be charged practically all of the increase in street-traffic accidents.

According to the latest surveys the total annual fatal accidents on the railways of this country are 7,800 as against 15,500 fatalities due to traffic accidents. Therefore, the loss of life in traffic accidents is twice as great as in railway accidents. As to an evaluation of the annual personal and other property loss from automobile accidents, Dr. F. S. Crum, statistician for one of the large insurance companies of this country, states that while an accurate computation is not possible, the annual sacrifice is fully $1,000,000,000.

In 1906 there were less than 400 deaths in the United States from automobile accidents while in this year the total will exceed 15,000 which is an increase of about 3,800 per cent and the total is steadily mounting higher.

Proper Illumination a Factor in Accident Prevention.—Stringent traffic regulations and educational publicity work have brought good results in many districts but they cannot overcome the effects of faulty vision caused by inadequate and improper street lighting. To determine how much value should be attributed to the proper illumination of accidents, a survey was made in a representative group of cities. In order to obtain uniformity in the reports, blank forms were prepared by the Engineering Department of the National Lamp Works providing for a charting or accurate tabulation of all traffic accidents in a given city during the period of one year. On these data forms returns were obtained from 32 representative cities such as Philadelphia, Boston and others, with a combined population of over 7,000,000. The period covered by the returns was in most cases from the middle of 1919 to the middle of 1920. Some of the essential facts derived from the

data compiled are in condensed form as follows:

1. That of the 31,475 accidents reported, 1,678 or 17.6 per cent were night accidents due to the inadequate lighting.

2. Applying this rate to all cities of the U. S. we find that no less than 567 fatal accidents occur annually due to inadequate lighting.

3. In addition to the suffering and loss of life an evaluation of the economic loss gives us the substantial amount of $54,000,000 chargeable to the lack of light and according to census reports the total annual expenditure for street lighting in the United States does not exceed $50,000,000.

The percentage of 17.6 arrived at as the proportion of night accidents which may be attributed to lack of light is undoubtedly an extremely conservative figure, for the streets of the cities covered by the survey were illuminated at night by artificial lighting of varying degrees of effectiveness. So in an individual city where the need for better street lighting is especially evident, night accidents chargeable to lack of light may run as high as 50 per cent.

Night Use of Streets in Trucking.—Among manufacturers it is realized that great savings in the cost of production are brought about by a double-shift which spreads the overhead or fixed charges over 24 hours as against 8 or 12 hours. This practice may be followed with equal economies by applying the double-shift to trucking which, according to reports, has in some cases reduced trucking costs almost one-half, due to the increased utilization of equipment and terminal facilities. This night use of streets can be fully developed only by providing improved street lighting. The double utilization of crowded thoroughfares is advocated not only because of its economy from the operator's point of view, but to relieve day time congestion and to postpone the time when expensive duplicate thoroughfare construction will be required by the increasing volume of traffic.

In driving at night, whether it be a truck, passenger bus, or private car, the driver's vision depends upon the fairly constant illumination from the street lights, his own headlights, and the spasmodic, violent influence of approaching headlights. Excepting grade crossings, the greatest danger to automobile drivers is from glaring headlights and with the growth in automobile traffic it is evident that some solution of the headlight problem must be brought about. Apparently there are only two really effective solutions, namely:

1. The establishment of one way streets and interurban or trunk highways.

2. The lighting of trunk highways so that with dimmed headlights cars may be operated with safety and in comfort at the customary cross country speeds.

The Lighting of Highways.—Efficient highway lighting fixtures have been developed and their use is being advocated by the leading manufacturers of street lighting equipment, and is sponsored by the Illuminating Engineering Society after considerable study and experimenting.

The cost of lighting a highway usually does not exceed 5 per cent of the cost of duplicating the highway in order to provide for one way traffic, so it is obvious that the second method is more economical than the first.

Many states have put into effect very definite regulations requiring the use of improved headlight lenses, governing their adjustment and various other details. Some have employed illuminating engineers and maintained a substantial force of traffic officers especially trained for competency in enforcing headlight legislation, but the most conscientious and persistent supervision has met with very little and unstable success. The solution lies in applying sufficient illumination to our main highways so that drivers will not need their headlights except as markers to define the width of the car or the limits of the area to be avoided in passing, and on city streets to make the approach of automobiles readily apparent to the pedestrian.

The precautions taken to protect the motoring public by posting all sharp curves, narrow bridges, steep grades and the like may be made to serve their full usefulness by proper highway lighting. At present this protection does not extend adequately beyond the hours of daylight.

Trucks as a rule operate at fairly low speed and at slow speeds headlights often afford little illumination so the driver is likely to strike obstructions or holes and do damage to both truck and highway. Many a load has been delayed for hours and sometimes for days because the driver

misjudged the edge of the road bed and sank into soft ground. In addition to disrupting schedules and lowering the equipment utilization factor the road is injured when heavy loads ride on the very edge of the road bed.

The cost of good highway lighting is justified by these considerations alone and apart from thoughts of comfort and fear of holdups.

Effect of Irregular Ends on Concrete Test Cylinders

Some months ago the results of a laboratory investigation made by D. V. Terrell, testing engineer of the Kentucky State Road Department, of the effect of irregular ends of concrete cylinders on compressive test were published in Engineering and Contracting. Since that time the investigation has been carried further, the idea being to arrive at a reliable method of evening up the ends on poorly-made cylinders in such a way that the results of compressive tests will be correct. This set of tests, comprising a second series, is described by Mr. Terrell in the Kentucky Road Builder, from which the notes following are taken:

In the first series the following results were obtained:

	Per cent
Perfect ends	100
Sheet lead bearing	51
Beaver board bearing	54
Plaster of Paris bearing	74
No bearing uneven end	59

In this series the cylinders were made 12 in. long, 1:2:4 mix Ohio River sand and gravel.

AGE 28 DAYS

First—Three ends perfect finished.

Results.

Pounds per square inch	3,310
Pounds per square inch	3,160
Pounds per square inch	3,200
Mean—Pounds per square inch	3,223

Second—Three made as above with the exception that the ends were left rough 14 days before the test was run; we put on a 1 in. cap on each end.

Results.

Pounds per square inch	3,280
Pounds per square inch	3,410
Pounds per square inch	2,900
Mean—Pounds per square inch	3,196

Third—Three made the same as above, 1 in. cap added on each end 7 days before breaking.

Results.

Pounds per square inch	2,980
Pounds per square inch	3,225
Pounds per square inch	3,540
Mean—Pounds per square inch	3,248

Fourth—Three made same as above; caps put on 4 days before test was made.

Results.

Pounds per square inch	2,900
Pounds per square inch	2,870
Pounds per square inch	2,950
Mean—Pounds per square inch	2,906

It was then thought that there may be some difference in the cylinder being 14 in. long instead of 12 in. Another set of cylinders were made 10 in. long with the idea of putting a 1 in. cap on each end. All cylinders were made with the same material.

First—Three 12 in. long, capped when made.

Results.

Pounds per square inch	2,760
Pounds per square inch	2,740
Pounds per square inch	2,800
Mean—Pounds per square inch	2,766

Second—Three same as above, but 10 in. long and rough 1 in. cap on each end. Tested when cap was 21 days old.

Results.

Pounds per square inch	2,730
Pounds per square inch	2,820
Pounds per square inch	2,770
Mean—Pounds per square inch	2,778

Third—Three same as above. Tested when cap was 14 days old.

Results.

Pounds per square inch	2,720
Pounds per square inch	2,660
Pounds per square inch	2,910
Mean—Pounds per square inch	2,763

Fourth—Three same as above. Tested when cap was 7 days old.

Results.

Pounds per square inch	2,770
Pounds per square inch	2,880
Pounds per square inch	2,740
Mean—Pounds per square inch	2,796

Both of these experiments proved to be very satisfactory. It is now recommended:

(1) That in the future all field cylinders be made 10 in.

(2) That no attempt be made to finish the ends.

(3) That they be capped after they reach the laboratory.

(4) That all caps be at least 7 days old.

It is believed that we will come nearer getting the actual strength of the specimen in this way than we have in the past.

Methods of Constructing Concrete Pavements

Modern Developments Described in Paper Presented at the 9th Annual Michigan Conference on Highway Engineering at University of Michigan.

By E. G. WILLEMIN
District Engineer, Michigan State Highway Department

The scarcity of labor and the uncertainty of material delivery have been prime factors in inducing the highway construction industry to employ more highly developed machinery. The tendency is to more closely standardize the product and in turn increase its rate of production. In promoting this tendency we approach the industrial plant idea to place the product on a quantity production basis

A new perspective has been gained in the consideration of a road project as a co-ordinated entirety, rather than a conglomertaion of its parts. The bidder now views a prospective job by analyzing its parts and then assembling the parts into a whole. The vital parts receive first consideration, his organization may be the heart of his job, it makes the job go, but his transportation facilities and his material supply are equally as vital to his well being as a builder as his arteries and life blood are to his personal well being. His consideration of supply and transport of material is interlocked with local aspects of the job such as soil, gradients, width of subgrade, water supply, condition of adjacent roads, length of the project, supply of common and skilled labor, length of live and dead haul, availability of local materials, time limit of the contract and his capital investment.

Preparation of Subgrade by Means of Subgrader.

The experience gained so far in the design and fabrication of road equipment has led to types that are labor saving devices, dependable at all times. Present construction demands sturdy, heavy duty types. Standing beside a modern mixer while in operation, one can well experience the same thrill, a feeling of awe, of surplus power and strength that one gets from the modern locomotive. The certainty of mechanical performance is eliminating a source of risk to the builder. Time-study analysis can well be applied with profit to each of the more costly major mechanical operations. Minor operations can then be

co-ordinated with the major operations to give a well balanced plant and organization. In glancing over a season's record, a sensational run on a single day is striking, but to the experienced builder the average runs per day spread over the season's work tells whether financial returns will be written in black or red ink. There are certain features with which road building must always contend, such as variable working location and lack of protection from the weather. The tendency now is to eliminate the factor of seasonal work as much as possible by starting work earlier. In any event the factor that counts is continuous production.

Economic and Social Aspects.—I have spoken of the physical and mechanical aspects as they may affect present methods. The economic and social aspects also show signs of recent development. Large contracting firms, with unlimited capital, are being attracted to this field of construction. Due to the larger plant investments and necessity of closer supervision there is a decided improvement in the personnel of the organizations. From the social standpoint the use of more highly developed machinery tends toward a general improvement of the class of labor formerly employed.

In the consideration of the present methods of construction of cement concrete pavements, it will be assumed that the foundation, subgrade or earthgrade and the drainage features of the road have received the painstaking care that is now considered absolutely necessary in go practice. For convenience the su ject will be handled in the sequen of operation, that is, the metho employed in (1) the preparation the flat subgrade or earthgrade f the slab; (2) the movement and ma pulation of material; (3) the finis ing of the concrete surface. The su ject of construction details will al be considered as to their effect up the builders' and users' viewpoints.

Preparation of Subgrade.—In t preparation of the flat subgrade f the slab, it is the practice in Mic gan to channel out sufficient ear from the full width of the slab to su depth as to give the proper cro section and volume of earth to co plete the shoulders at the edge of t slab. On fresh subgrade or up loose soils a grader serves well remove the excess earth outside t shoulder line for future use. On su grades well packed by traffic or stiff soils it becomes necessary to u heavier equipment in such tools the plow, scarifier and grader. The has been and still is considerat discussion as to the merits of cha neling for the slab. From the en neering standpoint in controlli volumes of earthwork it is necessa to use the surface of the flat su grade or earthgrade as the pla which eliminates the item of exca tion from further considertaion. the other hand, it means that t earth channeled from fills is handl twice. This fault is partly remedi by building our earthgrades 6 i wider on each side than the finish

Subgrade Prepared for Pavement Section, 9 in. at Side, Tapering to 6 in. in 2 ft.

vidth with the idea of using the vedge of earth of the inner ditch lope as a source of filling material or shoulders. In flat sandy country, hanneling may be almost dispensed vith while in rolling country it beomes more difficult for the engineer o balance the deficiency that may xist in cuts and fills to avoid endwise aul. In practice it has been found dvantageous to have the engineer ctually channel out a strip several eet wide to the cross section as hown on the plans to demonstrate hat in that class of soil sufficient epth has been reached, with or withut the wedge of earth on the shoulder, to adequately fill out the shoulders

usually guarantees a decreased cost. Each time material is picked up to move, costs rise also, due not only to the cost of movement, but waste of material as well. Yard layouts are now designed to elevate raw material but once, if possible, and to take advantage of gravity movements thereafter.

The Location of the Mixer.—We find that in general two classifications may be made as to the location of the mixer, viz.: (1) the mixing operating on earthgrade fed by transportation units; (2) the mixer operating off the grade and delivering a wet batch to the transportation units. Under the first classification we may

Delivering Material to Mixer from Central Plant by Industrial Railway.

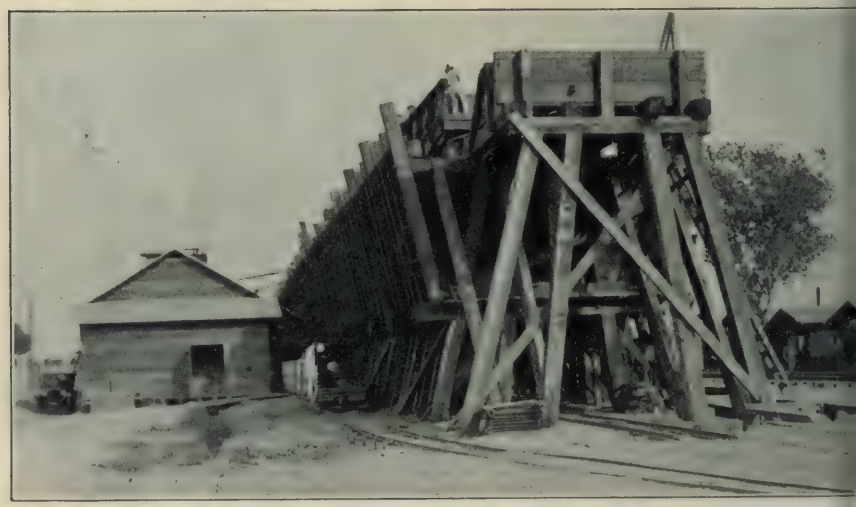
n the edge of the slab to its proper lope and section. The present tenlency is to eliminate side ditches as nuch as possible, but still provide dequate drainage and yet leave no hastly borrow pits on the back lopes. These restrictions imposed pon the engineer makes close conrol of earth work necessary at all imes.

The vital importance of the supply nd transportation of material has lready been touched upon. The supply should always be at least equal to, ut never less than consumption reuirements to insure continuous proiuction with a well balanced plant. The facilities of unloading materials rom a source involving railroad haul nd for its proper storage is thereore given careful consideration. A ayout that gives a minimum handling

subdivide into three types, the wheelbarrow or stocking of subgrade system, the central proportioning plant or a type not used to any considerable extent, which consists of a mixer over which storage bins are erected, the bins being filled by a hoisting arrangement and the whole cumbersome affair mounted on rails. Due to the fact that the transportation element must also be considered with each type of mixer layout, I will continue the enumertaion of types of mixer layouts not operating on the subgrade, then return to a closer study of each type of layout in its relation to transportation as well as its peculiar advantages over other types. Under the classification in which the mixer does not operate on the grade we have two types: (1) central mixing plant with mixer fixed

and set up adjacent to main source of material supply; (2) a modified central mixing plant where the mixer requires one or more set ups usually adjacent to the road, its location determined by stock pile or source of supply. It will be noted that the essential difference in types as far as transportation is concerned is the hauling of a dry or a wet batch. There are other considerations previously mentioned, however, that largely determine the location of the mixer in respect to the road and the methods of transportation. I will repeat them, assoil of subgrade, gradients, width of subgrade, water supply, condition of adjacent roads, length of the project, supply of common and skilled labor, length of live and dead haul, availability of local material, time limit of the contract, and capital investment.

The Wheelbarrow Method.—With the mixer operating on the subgrade, let us first consider the wheelbarrow method. This method is still in use, but usually in localities where unskilled labor is plentiful and cheap. Aggregates are usually stocked upon the subgrade. In such a case, it is necessary to space the loads of each type of aggregate with care to save long distance wheeling. This requirement would mean a very trustworthy foreman in charge of unloading. Again, with materials stocked on the subgrade any corrections that must be made to the subgrade after th aggregates are placed, are very costly For this reason unusual care must b taken to correct all ruts and unever ness of the subgrade prior to stock ing. There is a considerable loss o material, as aggregates cannot b picked up clean and economicall without combining parts of the sub grade with it. This waste materia may run as high as 10 per cent. Th human element enters into this meth od too largely, there is congestion questionable morale and heavy labo turnover. There is no advantage i stocking subgrade in anticipation o scarcity of material that cannot no be offset by dry batch delivery fro



Central Proportioning Plant on Arizona Road Job.

the stock pile. A late development i the use of belt conveyor as a sub stitute for the wheelbarrow. Thi contrivance eliminates the commo labor element, but does not reduc waste of material. When aggregate are not stocked on the subgrade d livery of material to the mixer may b made by industrial railroad, light o heavy truck. The reliability of mixe supply, however, is questionable i this method. Moreover it has bee demonstrated that the batch syste handles the transfer to the mixe more economically. Unless materi can be stocked at railroad sidin there is a possibility of the accumul tion of demurrage charges.

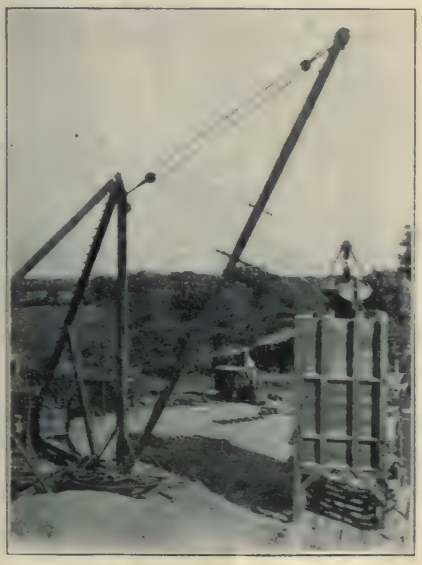
The Central Proportioning Plant.—As the name infers, the central pr

portioning plant proportions the aggregates in a dry batch to correspond to the capacity of the mixer. The plant may be composed of fixed or movable loading bins that serve for storage of aggregate, or a tunnel arrangement designed to accommodate an industrial train. Batches may be proportioned by hoppers on the discharge chute of the loading bin or tunnel or by volumetric measurements in compartments of a batch box or of partitional truck bodies. Batch boxes may be of the tilting, side discharge or drop bottom type. If cement is included in the batch, separate compartments for it are preferable. Covers are now provided for cement compartments as a safeguard against wind and rain. The ideal layout for loading is to elevate material but once, so that handling of materials to the transportation units is by gravity. In some large layouts using truck haul, separate loading bins for each aggregate are used. This arrangement requires two stops. In smaller layouts, where truck haul is used, it is possible to have sand and gravel compartments for each loading bin, thus eliminating one extra stop of the truck per trip. There are likewise opportunities to design tunnels so as to economize on train loading time and dead storage of material.

In the consideration of the effectiveness of the central proportioning plant we are at once confronted with our transportation problem. In general the light or heavy truck or a combination of both, or the industrial train alone, or in truck combinations is employed.

It is argued that the cost of delivery of material in this manner is no more than with a wheelbarrow layout and that the cost of operation and wear of the light trucks does not exceed the cost of reshaping the subgrade that is necessary with certain soil conditions when heavy trucks are used. On a long haul by truck delivery it is also argued that a saving can be affected in handling of material by delivery in heavy trucks to a stock pile, provided the heavy trucks can dump directly into hopper of a loading bin to be later discharged into hoppers for loading light delivery trucks. The cement may or may not be added to the batch at the central proportioning plant. Depending upon the source of cement supply, it may prove feasible to stock the cement in a movable storage house on the road. The methods mentioned contemplate the material brought by truck or train to the mixer, with the mixer gradually progressing forward. A recent plant layout using dry batch heavy truck delivery was so arranged as to temporarily fix the location of the mixer every 1,500 ft. on the subgrade with the mixer discharging concrete into light trucks for placement on the subgrade. It is needless to say that a turntable would be one necessary piece of equipment in such a layout.

Transportation Methods.—Among road builders, the problem of the transportation unit to be used for a given project creates considerable discussion. One builder's experience may have involved the light truck, another the use of heavy truck, while still another the industrial railroad. Contracts have been completed by the use of each type or of light and heavy truck combinations equally successful from the standpoint of the contractor. It is my opinion that the temperament of the contractor and his organization enters into the choice, in other words, a personal equation may be involved. Some builders are willing to take more grief from their equipment than others, as manifested by the maintenance they



Material Handling at Central Plant.

give the equipment. Besides this consideration there are the more important ones of plant investment, fixed and operating charges.

It has been found that certain economical principles apply as well to road equipment as to other types of machinery. Let us consider a few of these principles. It cannot be disputed that where interest charge on the investment plus depreciation is exceeded by the loss due to costly delays in the use of old equipment that new or better equipment should have been purchased. The economy of new or well maintained equipment is apparent where repairs or replacements are difficult to obtain. A piece of equipment is not justified in a well balanced plant unless it co-ordinates closely in output with other units of the plant in giving continuous production. This does not mean for instance that the capacity of the clam at the unloading plant per 10 hours must be equal to the total aggregates handled in 10 hours by the mixer. Its capacity may be less, it may work overtime to maintain the balance of supply with demand, but its capacity should be such that demurrage does not pile up unnecessarily due to erratic shipments, or delays caused to other plant units. Equipment standardized such as mixers now are should not be overloaded. The machine may stand the strain for a time, but maintenance and depreciation charges will soon discount the apparent advantage. Workmanship suffers also.

Adapting Projects to Plant.—After a road builder has bought his plant and completed a successful season's work, he has no assurance that his plant will balance with the requirements of the next job. There is an opportunity at times for the state and counties to adapt projects to plants. It has not always been possible to do this, however, because of considerations such as taking care of traffic during construction. It is sometimes advantageous to advertise a short job. A small job with a small organization and small overhead can compete favorably in unit price witn a large job with large organization and high overhead. The risk of delay is more costly in a large plant layout. The small plant layout has proven adaptable to a larger variety of jobs. It is true that the large plant may not have yet had the chance to demonstrate its worth due to the uncertainty of material supply. To date it is my opinion that the average net return on the money invested for the large plant has been lower for a season's run than the small plant. The efficiency of the construction organization is responsible to a great degree for its success or failure. With improper equipment an efficient organization soon loses its efficiency and its interest in the welfare of the work.

Central Mixing Plant on Iowa Road Job.

Truck and Industrial Railroad Haul-

ge.—To return to the question of ransportation units, to those who ad the opportunity to hear the ad- ress on the effectiveness of the light nd heavy truck and the industrial ailroad at the recent Chicago con- ention, the reasons for variances in pinion are apparent. A few of the oints brought out for each type will e mentioned here. With light truck aul, a light truck being considered -ton capacity or less, the light truck akes up in speed what it lacks in apacity. Its use is favorable with comparatively short hauls, it is easier on the subgrade, parts are more read- ily replaced in case of breakdown, the time lapse is shorter after a rain for trucks to start running upon roads, the interest charge on the capital invested is less. An apparent advantage is the fact that truck drivers may be obtained at cheaper rates than for heavy trucks, also mechanics, but how true ultimate costs will be cut is problematical. The investment of the owner in spare parts, however, is appreciably cut. With heavy trucks, on the other hand, a long haul is more advantag- eous. Due to the fact that for a given volume of haul, a less number of heavy trucks are needed, they require less field supervision, there are fewer units on the road to pass each other, less time to load than in four or more light trucks, they are on the subgrade a shorter time in unloading the same volume, thus disturbing sub- grader work less. The drivers take more personal pride in the perform- ance of their heavy truck. In fixed charges, the storage charges per heavy truck is less than for its ca- pacity equivalent in light trucks, license fees are accordingly reduced while risks on insurance, liability, fire and theft are less. The charge off for the life of heavy trucks can be taken as twice that of light trucks. Again in subletting truck hauls, it usually proves more satisfactory to sublet to heavy truck haulage concerns, as they are more substantial and trust- worthy in general. There are evils in subletting truck hauls, however, due to the fact that the contractor loses his absolute control over his transportation units and condition of his subgrade. Trucks equipped with adequate tires for the capacity of the truck are essential as a remedy for subgrade troubles.

Dumping Dry Batch; Note Apron on Bottom of Mixer Skip.

The heavy investment necessary for industrial railway equipment is war- ranted only on longer projects. Their layout and operation require close study in regard to soil conditions, weight of track, grades, booster en- gines, temporary and permanent

passing switches, loading facilities and tracks using gravity wherever possible in favor of the load. Undoubtedly railroad economies can be profitably applied on some phases of its operation. It has been found that heavier loads should be drawn with the same power unit, or it is more economical to boost on heavy grade than it is to cut the load. Within the last two or three years the power unit has increased in weight and consequently increased the tractive effort with the necessary power. The industrial haul is more reliable in general as a transportation unit than the truck method. The reliability of the industrial haul should lead to continuity of production. Against this advantage we must charge added interest and depreciation of plant investment.

In the comparison of the effectiveness and economy of any transportation unit, the cost per ton mile haul seems the logical basis for comparison. On a given project with a given output of the finished product, the volume of material required in tons is constant. The mileage and time involved in hauling are the variable factors of the ton mile basis. We may decrease the tonnage per transportation unit and increase the speed of each unit or vice versa, and obtain the same output within reasonable limits. The analysis of these factors for each project gives the builder the clue that he seeks as to the type to employ.

Central Mixing Plant.—As previously stated in the plant layout where the mixer does not operate on the subgrade, we are concerned with the so-called central mixing plant or a modification of it. In one case the mixer is fixed quite permanently, in the latter case the mixer can be shifted from stock pile to stock pile. The former must have materials brought to it, in the latter the plant is more flexible in that respect. The operation of the central mixing plant is particularly affected by its design. The bins should deliver a uniformly graded type of each aggregate. The proportioning of the batch should be done just prior to discharge into the mixer. The central mixing plant layout centralizes activities; it would therefore cut supervision costs. This is not so true, however, of the modified type. The modified type might be used economically where heavy truck hauls are necessary to various stock piles along the road, with the soil conditions of the subgrade such that only light trucks could be used for hauling wet batch. Many different types of portable elevators are now on the market for handling aggregates from stock pile to truck or industrial railroad, that could be adapted to the modified central mixing plant.

Many specifications do not allow,

Curing Concrete by Ponding Method on Alabama Road Job.

others restrict the use of concrete mixed by the central mixing plant method. Those that oppose its use contend that segregation of aggregates occur in the concrete in its transportation, especially where long hauls are involved over rough roads. Truck haul is advisable, as by it individual batches are delivered to the project in the least time. Tests were made a year or more ago to determine the probable safe maximum haul of concrete mixed in a central mixing plant. The results as given in Public Roads, the former official publication of the United States Office of Public Roads, show in a general way the relative strength and consistency of gravel concrete when hauled in a wet batch and tested at various periods of time up to three hours after initial mixing. The concrete was mixed to a consistency to conform to a 2-inch slump with standard apparatus. Cylinder specimens were made for testing according to standard field practice. It is stated that the experiment indicates that the most practical way to utilize the central mixing plant in concrete road construction is in connection with a machine finisher. It also indicates that so long as the concrete is workable after a period of hauling the strength will not be affected. Further experimental work was to be conducted on the effectiveness of this method.

The Inundation Method.—One of the more recent developments in the mixing of aggregates for concrete is the so-called "Inundation Method." It consists of measuring the sand aggregate in a container which has previously been partly filled with water in such quantity that when the container is level full the sand is completely soaked. The effect of moisture on sand is variable, depending upon the physical characteristics of the sand. Experiments show that the swell of dry sand measured after moistening by the addition of 2 per cent of water by weight may easily be 15 per cent. With like increments of water added, the volume tends to decrease to the saturation point. With a soaked sand, volume measurements become more constant. By this method the consistency of concrete can be more closely controlled. Experiments indicate that the compressive strength of concrete made of a given grading of aggregate varies inversely as the consistency of the mix. By the use of the inundation method of proportioning sand it may be possible to specify concrete by its strength rather than by its volumetric proportions. To my knowledge no practical adaptation has yet been made for using this method in actual construction, although there are no serious obstacles in the way of doing so.

The use of bulk cement has not been developed to the extent it could be. The standard sack of cement has been used so long in proportioning aggregates that the custom seems fixed. With storage bin facilities it is used successfully on both the central proportioning and central mixing plant types.

Curing the Slab.—In the curing of the slab, it is general practice to maintain moisture and temperature factors as near as may be at normal conditions. The top of the subgrade is kept moist, so that soil will absorb as little moisture from the concrete as possible. To retard evaporation and to reduce internal stresses, canvas canopies are placed over the concrete surface after finishing, or as soon as the concrete is sufficiently hard the surface is covered with water or moistened earth. These precautions make the rate of curing more uniform. The addition of reinforcement to the slab has no beneficial action in curing, as during contraction the steel has formed no bond with concrete.

Considerable progress has been made in the development of the finishing machine. It is a labor-saving device and I might say a life-saving device to humanely express its improvement over hand finishing. By the use of such a machine, a drier, consequently a stronger, concrete can be properly laid. The tamping action is particularly effective, tending to make a denser concrete and to flush grout to the surface for a smooth finish.

Details of Design of Pavement.—The design of the pavement is not within the scope of this paper. There are certain details of design, however, that affect construction methods, not materially, but sufficient to cause the builder some wonder as to how much work they will entail. I mention but a few of the most noteworthy developments. The central longitudinal joint is generally placed to prevent a long crooked longitudinal crack. It is claimed that it increases about four times the beam

strength of the half slab, acting as a beam. Steel dowel bars are placed transversely across the joint to act as tie-bars. The placing of the stiff dividing joint and the steel dowel bars in advance of the placing of concrete has not proven a drawback whatever in the efficient prosecution of the work. Systems of steel reinforcement of the slab are now so fabricated that their placing above the subgrade does not interfere with other operations. The shape of the cross section on the bottom of the slab or the top of the subgrade has not been standardized. This detail works no particular hardships on the builder, however, as far as methods are concerned.

In regard to details of equipment, some specifications require the use of steel side forms exclusively. This is quite necessary where a machine finisher is used. With the tendency towards concrete of firmer consistency, mixers are provided with accurate water gauging devices. Timing devices are also considered necessary. The boom and bucket system of distribution, after discharge from the mixer, is favored, as a drier mix can be used satisfactorily and segregation of aggregates prevented.

With the opening of pavement to traffic, the traveler is at once impressed with its riding qualities. The smoothness of finish, its freedom from unevenness are factors of prime importance to him, momentarily overshadowing the importance of the strength of the pavement. In specifications, the limits of variation from a true surface are being drawn still closer. Expansion joints, where placed, must have their top edges truly flush with the adjacent concrete surface. Every detail of construction in fact is given painstaking care.

In conclusion a summation of the most striking developments that affect the methods used in this type of pavement would include the tendency towards the mechanical perfection of labor-saving devices, plant coordination, security of material supply and large capital investments with a well trained and efficient organization.

Economic Highway Bridge Problems

A Paper Presented at 9th Annual Michigan Conference on Highway Engineering at the University of Michigan

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The function of an engineer in construction work is to solve his problems so that adequate service will be rendered at minimum cost. This is a basic principle easy to state but difficult to carry out with any degree of uniformity because just what constitutes "adequate service at minimum cost" is a matter of judgment which in turn involves differences of opinion. Furthermore, engineering problems relating to highway bridges cannot be entirely disconnected from similar problems relating to the adjacent roadway. The best solution of a bridge problem might not be so for the adjacent roadway, and vice versa. The effect of each upon the other in particular cases should be carefully considered, and to a certain extent it is one problem instead of two, having in mind the best interests of the highway as a whole.

Obviously the study of all highway bridge problems from a broad economic viewpoint involves the probable permanency of the structure; and it is to that particular phase of the subject that this discussion will relate. Again it must be remembered that bridges are integral parts of the highway, and as such the extent of their future usefulness is subject to the same uncertainties that surround our highway transportational facilities in general. Difficult, however, as it may be to forecast all of the conditions affecting the useful life period of the roadway portions of a highway system, there are many reasons why the problem relating to bridges is even more complex. From their very nature bridges have to perform a two fold service, that which is incidental to the passage underneath as well as that which is required by the traffic over them. Hence radical changes in either respect from the conditions for which any particular structure was designed will affect the useful life period of the bridge. Although a fixed bridge, by which is meant one that has no moving mech-

nism, does not wear out to any reater extent than the roadway surace, which represents a small cost ompared to that of the bridge as a hole, the materials in the bridge roper may disintegrate more rapidly han those in the roadway. Repairs r reconstruction may be long deerred in a roadway, while weak spots n a bridge require immediate attenion.

Life of Structure and Initial Cost.—s a purely business proposition the robable permanency of a structure s a question that should be taken nto account together with that of nitial cost. It would be poor policy ndeed to buy a structure of low riginal cost but which required exensive repairs soon after its compleion or which would have to be replaced at a comparatively early date. Unfortunately, however, the useful ife period of a structure involves so nany uncertainties that it cannot be lefinitely anticipated. Perhaps the best we can do is to base our judgment of the future upon the past, although the disappointing thing about uch a procedure has been to find as ach year's developments passed into istory, that our most liberal expectaions for that particular period have een far exceeded. In the light of istorical data the outstanding facors affecting the useful life period of bridge are:

1st. The relation between the caacity for which the structure is deigned and that which may later be equired.

2d. The deterioration of materials f which the structure is built.

Other circumstances affecting the ermanency of bridges such as reloation of a section of highway or adical change in profile for the purose of reducing grades do not fall ithin the intended scope of this disussion. Unfortunately from the tandpoint of attractiveness of our ublic structures, the appearance of bridge has little influence upon its ermanency, and a structure unightly when built must be endured ntil for some more practical reason is discarded.

Capacity and Life Period of Bridge.—With reference to capacity, the life eriod of the structure can be partially ontrolled by the designer dependng upon how liberally he proides for future requirements. Just hat might be considered reasonable iberality in the matter of future increases in traffic, however, is clearly a matter of opinions, and it is not unlikely that designs based upon them will fall as wide of the mark in the future as in the past. For the purpose not of offering an explanation for the inexcusable lack of foresight on the part of the designers in special cases, but rather to demonstrate what little chance a real prophet of a decade ago would have had in convincing the average road commissioners of the accuracy of his vision regarding highway usage, some statistics relating to the growth in volume of highway transportation are pertinent. The registration of motor vehicles in the United States, by which is meant both passenger cars and motor trucks, increased from 1,033,096 in 1912 to 10,448,632 in 1921, or over 1,000 per cent; the registration of vehicles in two states alone in 1921, namely, New York and Michigan, exceeded by 222,700 the total registration in the United States in 1912; and the increase in registration of 1921 over 1920 in the United States despite a poor year for motor vehicle production also exceeded the total number of vehicles in 1912. With these facts before us, it is no wonder that many bridges constructed ten years ago with allowances for future increases in traffic which were then considered reasonable by the designer, are inadequate today. The surprising thing about it is that so many bridges have survived. A comparison of the volume of motor traffic of today with that of 20 years ago shows an even more startling development. Because of lack of registration we do not have at hand accurate figures regarding number of vehicles for that early period, but such production records as are available indicate practically no motor trucks and less than 5,000 passenger cars.

Difficulty of Making Roadway Fit Traffic.—To add to the difficulty of making the roadway fit the traffic, motor vehicles are unlimited in their field of action. Unlike the structures of a railway which are designed to meet the needs on particular systems, the highways are public and may be used by whomsoever desires to do so. Scientists tell us that certain insects which multiply with slightly greater rapidity than motor vehicles do not wander far from their place of birth. It is not so with motor vehicles. We in Ann Arbor are accustomed to see quite a sprinkling of

vehicles from foreign states, occasionally as remote as Florida and California. A good road to an objective point, however distant, advertises itself with remarkably prompt and voluminous results. All of which adds further to the uncertainty of just what the future requirements in any particular locality will be.

Furthermore, the above statistics refer to increases in volume of traffic, which is only half the story, as the capacity of a highway may be expressed in terms of either volume or weight of traffic. In passing, it might be noted that inadequacy of bridges with respect to volume of traffic has been more acute in recent years than with respect to weight. This is explained by the fact that the margin of excess usually provided in the design of highway bridges is greater for weight than for volume of traffic. A two-way structure is never more than that, while increases in service loads are always permissible in properly designed structures. In some respects this is a fortunate situation, inasmuch as inadequate volume capacity of a structure means simply throttled traffic involving moderate danger and delay, while failure under excessive load may result in fatalities and prolonged tie-up of miles of a highway system.

While the story of motor transportation reads almost like a fairy tale, it has its parallel in what has been done in a corresponding period in the development of good roads. In fact it is impossible to estimate the extent to which each has contributed respectively to cause and effect. The users of motor cars are numerous and influential enough to bring about road improvement. Road improvement in turn stimulates the use of motor vehicles and thus we have the one always chasing the other in an endless cycle as it were. Just when one will catch up to the other is of course impossible to tell, but naturally road improvement and motor car production will go hand in hand with abnormal speed until traffic on the highways reaches its economic level in the whole field of transportation.

Economic Position of Highway Bridges.—As an important detail in the process of road development to which reference has been made, highway bridges have occupied a peculiar economic position. Per foot of highway the average bridge is a comparatively expensive part of highway construction. Naturally, therefore, the cost of bridges is always reduced to a minimum consistent with service requirements. In the days of horse drawn vehicles, a country bridge was considered of ample volume capacity if wide enough for two ordinary vehicles to pass at slow speed or say a minimum of fourteen feet, and high enough, if there was overhead construction, to permit the passing through of a load of hay or a threshing machine. If perchance two vehicles should meet at a bridge and one be required to wait until the other one had passed over, the value of time in transit was not sufficiently great even to cause serious mental irritation. Nowadays, the situation is vastly different. With the advent of swiftly moving vehicles, transit time has taken on new standards of value and traffic interruptions are more serious. The loss of time thereby may have real or fancied value, but in either case pressure is properly brought to bear to remove the throttle.

Aside from the more or less serious delays referred to, there are other good reasons which tend to terminate the usefulness of many structures long before the materials with which they are constructed have dangerously deteriorated. A bridge which is inadequate with respect to volume of traffic is likely to be a real menace to rapid highway transit in that it contributes to many accidents either by collision with portions of the structure which project above the roadway, precipitation over high banks or both. It must be borne in mind that many drivers of highway vehicles are unfamiliar with the roads over which they are traveling and it goes without saying that in the interest of safety to the general public every reasonable precaution should be taken to minimize hazards.

Another feature of inadequacy in the design of bridges often resulting in serious damage and sometimes to the extent of complete failure is with respect to the waterway. Major defects such as scant opening for the flow under flood conditions or shallow bearing on the soil will directly endanger the piers and abutments; and stability of the superstructure being dependent of course upon that of the sub-structure, it is doubly important that every deail of the foundations be carefully studied and liberally designed.

Permanency of Bridges from Material Standpoint.—In discussing the permanency of bridges from the standpoint of deterioration of the materials of which they are constructed, we are standing on firmer ground. That is to say, the situation is not complexed by such uncontrollable factors as the development of vehicular traffic. The useful life period of a bridge in so far as the materials are concerned is largely dependent first, upon the kinds of materials used in construction, and second, upon the places where used and the care which is given in maintenance.

As a matter of common knowledge, for example, timber when alternately wet and dry will decay in a few years, and the only way to preserve it indefinitely is to keep it in either one condition or the other all the time. Practically it is easier to keep timber saturated with water than perfectly dry, and in substructure work sound timber which is always submerged in fresh water may be considered absolutely permanent. Samples taken from the timber in the substructure of the Belle Isle Bridge after about 30 years submersion showed absolutely no deterioration. Other similar observances are on record. The critical zone for timber in substructure work is adjacent to the water line, where the material is naturally subjected to alternately wet and dry conditions. Timber piles and grillages as frequently used in the foundations for bridges bear silent witness to that fact.

It is practically impossible on the other hand to prevent timber which is used in the superstructure of bridges from being wet or dry intermittently. Paint and various impregnating processes will go a long way toward preservation, although sooner or later decay is likely to get started at inaccessible joints. Complete housing is the only effective way to make the timber superstructure of a bridge reasonably permanent, but this is obviously an expensive expedient in the matter of first cost as well as in maintenance of the housing itself. The average lifetime of timber bridges in so far as the decay of the material in the superstructure is concerned may be estimated at from 12 to 15 years when exposed to the weather, notwithstanding the fact that in some cases they have been continued in service by careful maintenance for over 50 years. When thoroughly protected from the weather by housing, timber bridges may last indefinitely with comparatively inexpensive maintenance costs on the bridge proper. There are in fact examples of enclosed timber structures built nearly a century ago which are still in service to the discredit of so-called "permanent" bridges in their immediate vicinity. Danger of complete destruction by fire is always a hazard which cannot be avoided in a timber structure, and unquestionably this fact had much to do with causing metal structures to become popular long before they compared favorably with timber bridges in the matter of cost.

Steel and Wrought Iron Bridges.—Steel and wrought iron bridges would be absolutely permanent with respect to deterioration of materials if, as in the case also of timber bridges, the conditions to which they were exposed were ideal. Steel and iron, however, will slowly decay through oxidation or rusting whenever they come directly in contact with air and moisture. This action is sometimes referred to as a slow fire. Various chemicals and gases and stray electric currents tend to accelerate the oxidation. When submerged in water the rusting process progresses more slowly, depending upon the extent to which the water is aerated. The best way, therefore, of guarding against deterioration of steel and iron in our bridges is to prevent direct contact with air and moisture; and a film of paint is usually employed for that purpose. The practical difficulties in the way of perfect protection to the metal in a bridge by such method, however, are well known to those who are familiar with maintenance problems. Even though paint is applied at reasonably frequent intervals there are many inaccessible places where decay is inevitable and cannot be checked. Under ordinary conditions of exposure the most vulnerable points for the disintegrating influences are at pin and riveted connections.

With reasonable care in maintenance, however, the materials in a metal bridge are likely to be in serviceable condition when the structure has outlived its usefulness in any particular locality for other reasons. Wrought iron is less susceptible to corrosive action than steel, and as evidence of the durability of wrought iron bridges, there is an arch

bridge of that material built in 1835 near Pittsburgh which is still in service and in excellent condition from a corrosive resistance standpoint.

Strange to say, there are cases on record where metal bridges have been completely destroyed as a result of fire in the wooden floor or paving. In 1915, nine through spans and half of the draw span of the old Belle Isle Bridge in Detroit, were completely destroyed in that manner almost before the fire apparatus could arrive on the scene.

Concrete and Reinforced Concrete Structures.—Concrete and reinforced concrete is popularly conceived to be an absolutely permanent material without maintenance, but an examination of many existing concrete bridges or other outdoor concrete structures will demonstrate that such an impression is not unqualifiedly true. For various reasons which will not be referred to here except to say that sometimes they are decidedly obscure, concrete as placed in our bridges has a wide range in quality, and if in speaking of the absolute permanency of concrete, material properly designed, carefully mixed and placed is meant, the statement is doubtless warranted. If on the other hand the material is defective either with respect to design or fabrication it will fall far short of absolute permanency. As well expressed by Professor McKibben, the owner of a concrete structure should not be led to believe that in every case he will have something as enduring as Verdi's "Il Trovatore" or Dante's "Divine Comedia." Many outdoor concrete structures do in fact show positive deterioration after five, ten or fifteen years of exposure. There is especial danger when moisture can reach steel reinforcement, as the formation of rust sets up a tremendous pressure and usually results in spalling off of the surrounding concrete. It is only fair to add in behalf of good concrete as a bridge material that it will increase in strength as it ages. The ultimate strength in compression at the end of a year is about fifty per cent higher than at thirty days when it should have ample strength to develop the stresses assumed in design. Furthermore, the weight of a concrete structure is so great in proportion to that of the traffic that large increases in weight will have a relatively small influence upon the intensities of stresses in the concrete. These facts are of distinct advantage for concrete, considering the future weight adequacy of structures in which it is used.

Summary.—The factors which have to do with the useful life period of any particular structure may be broadly summarized into three points:

1st. Materials.
2d. Design.
3d. Maintenance.

There are proper places in highway bridge construction for the use of each of the three kinds of materials herein discussed, timber, steel and concrete. Their advantages and disadvantages respectively are well known through observation and experimental investigations, and with data at hand relative to comparative prices the designer is enabled to make a choice which will properly meet the requirements in any particular case.

Under design is the presumption that the materials regardless of kind will be economically and yet wisely proportioned. Full consideration should be given to the historical fact, that inadequacy either with respect to volume or weight of traffic rather than deterioration of materials of construction has been the prevailing cause of premature abandonment of highway structures; and the designer should always keep in mind the probability of required strengthening, or expansion of a structure before the materials have outlived their usefulness. Details especially should be liberally proportioned. Comparatively little expense may be added by excess material at critical points, and yet minor weaknesses may develop into a case of the tail wagging the dog in the matter of prolonged serviceability of the structure as a whole. The general type of structure selected has an important bearing on the practicability of volume expansion, in case the growth of traffic requires either a new bridge or an increase in width of the old one. If any structural portions of a bridge extend above the roadway it is in general impracticable to adopt the latter expedient, while a deck structure can usually be extended indefinitely in a lateral direction without interfering with a clear roadway. The deck arch type is particularly advantageous because of its expansiveness as well as appearance, and because of the temptation to use it quite generally for highway bridges,

a word of caution should be expressed, that is to make sure that the foundation conditions which have so much to do with the integrity of the arch type, are favorable for it.

In the final analysis, the useful life period of a bridge insofar as it may be affected by decay of the materials depends upon maintenance and repair. Careful and systematic inspection followed up by prompt attention to such defects as may appear from time to time is bound to result in prolonging the life of a bridge, whatever the materials of construction may be. Private corporations and especially railway companies are keenly sensitive to the value of thorough maintenance. probably for the reason that the benefits of longer structural life and uninterrupted service show up in the dividends. It is a notable fact that most steel and iron railway bridges replaced by reason of inadequate capacity are practically as good as new insofar as the materials are concerned. Highway bridges on the other hand are too often sadly neglected, painting too long deferred, shoe pockets allowed to fill up with dirt and vegetable matter, with the inevitable result that the life of many structures is unduly shortened. For reasons pointed out, there are some elements in the design of highway bridges which are pardonably misjudged, but there is absolutely no good excuse for careless inspection and maintenance. Whatever materials may be used in constructing a bridge, and whatever volume and weight of traffic it may have been designed to carry, there is no better and certainly no cheaper elixir of life than reasonable care and attention.

Economic Value of Good Roads

The following interesting item is extracted from a paper presented June 11 at the convention of the Canadian Good Roads Association by Geo. Hogarth, chief engineer, Department of Public Highways of Ontario:

There is a cash value to good roads in the saving of wear and tear on vehicles that cannot be too strongly emphasized. The benefits of good roads are shown by the reduced cost of maintenance and longer life of automobiles run over good roads on one hand and bad roads on the other. One type of car with which you are all acquainted and of which the Department has a number has been used by us since 1917 when our highway system was first assumed. The cars bought in 1917 and 1918 were run over the roads in the condition the highways were in when taken over and in some cases the cars were practically wrecked in a season's wear. When turning in such cars and renewing them we were allowed a sum of money which represented an average depreciation exclusive of repairs of $240 per car per year. In 1923 we turned in a number of cars for replacement and the actual depreciation was $125 per car per year. This is a saving in depreciation alone of $115 per car per year. With 272,000 cars and trucks in Ontario, many of which are more expensive than the car above referred to and half of which are owned outside the cities there would be a saving of $15,500,000 per year on depreciation on cars and trucks owned outside the cities, and using the low value of $115 depreciation per car per year.

Road Scene in Vicinity of Toronto, Ont. Wehr Grader Leveling Off Surface After Steam Roller and Scarifier Had Broken Up Old Macadam.

Regulating the Parking of Automobiles

Present System and Suggested Methods for Providing Space for Standing Cars

By JOHN IHLDER,
Manager, Civic Development Department, Chamber of Commerce of the United States

A few years ago automobile salesmen talked about the saturation point in terms of the public's buying power. They calculated the possible number of automobiles in a state by the number of families with a certain income. Today such figures, except as applied to the rural population, are going into the discard. The saturation point for automobiles is coming to be the incopacity of streets not only in cities, but even in towns and villages, to hold more cars.

We have suddenly awakened to the fact that the interesting game of regulating traffic, while the more dramatic, is not the more important part of our problem after all. The more important part is to find out what to do with automobiles, not when they are moving, but when they are standing still. Until some inventive genius invents a collapsible car that can be folded up and put into the hall closet or a corner of the office this question of what to do with an automobile when it is not in use is going to cause more and more concern to manufacturers and salesmen and to would-be owners than ever has been caused by justices of the peace with a keen eye for local revenues.

Of course we have been making tentative and superficial efforts to answer this question for some time, but with results so unsatisfactory that in the largest cities car owners have given up the attempt to drive to their offices near the center and even in moderate sized towns the merchants, the police and the car owning public are most dissatisfied with these results and with each other.

Limiting Use of Automobiles in Downtown Area.—So recent is our realization of this problem that there are regulatory authorities who still approach it from the point of view that the autombile owner is more or less of a nuisance who should be thankful for whatever facilities are grudgingly granted him, and some traffic experts who maintain that inasmuch as two or three riders in an automobile take up more space in a city street than do several times that number in trolley cars or subway trains, therefore the answer is to limit more and more strictly the use of autombiles in downtown areas, perhaps confining it to taxi-cabs which, being more constantly in use, serve a greater number of passengers and call only a fraction of the parking space.

Of course such a solution as this is no solution, but is rather a method of intensifying conditions that make for further overcrowding of our already overcrowded business and apartment house areas. The means immediately available for dealing with the standing automobile are limited and, are largely in the nature of more or less unsatisfactory expedients. The first requisite is to approach the problem from the point of view that the automobile, passenger car as well as delivery truck, is a necessity of modern life and that our purpose is to facilitate its use.

Generalizations for Guides.—The degree in which various expedients may be used will vary in different cities and towns according to local conditions. There are, however, some generalizations which may be used as guides.

First, the streets are designed for transit. Consequently they must be kept free from standing vehicles to the extent necesary for an even, uninterrupted flow of traffic.

Second, the entrances to hotels, office buildings, large stores and other buildings in which there is a great amount of coming and going must be kept accessible.

Third, so far as is consistent with the foregoing, car owners should be permitted to park their cars on the public streets or other public space in front of or close to their destination and leave the cars there all day if they so desire. The third generalization is, of course, an ideal and as with ideals can be only more or less approximated.

Between all day parking and the stop to discharge passengers before a hotel, there are gradations in time limits the value of which is still largely theoretical. Whether a 15 minute parking limit is, as a rule, of practical

ıse, may be questioned. For the man who reads your gas meter this would be ample. Perhaps is should suffice for the life insurance agent. But it is not enough for the woman who is buying material for a new set of curtains or for the family dinner. Perhaps we shall come to a simple three-fold classification of parking spaces on business streets; stop to discharge passengers, shipping stops which may extend from fifteen minutes to half a day, and all day parking.

Providing Supplementary Parking Space.—But with all the time limit expedients we can devise our streets in the business districts and in many apartment house districts are now inadequate to contain all the cars whose owners wish to park them there. Supplementary parking space must be provided.

In towns and cities where there are considerable areas near the business section—but not with valuable business frontage—still unbuilt upon, the municipality should acquire these and maintain them for automobile parking. It may charge car owners a small fee for this service on the principle that it charges users of city water, or it may give the accommodation free on the principle that it permits free use of the sewers, to take care of what might otherwise become a public nuisance.

In nearly all cities, large as well as small, there are considerable areas in the centers of blocks, even in downtown districts, now disused or wastefully and uneconomically used. So long as these block centers remain in private ownership they are a constant temptation to the erection of deep, solid buildings the lighting and ventilation of which is difficult and expensive. There is an economical depth, just as there is an economical height for a store or office building. Where blocks or squares are so large that this economical depth is exceeded, the rear ends of the lots may well be thrown into one open space and used for parking. Incidentally such a use, meeting a real need, would greatly lighten the task of those called upon to enforce those sections of a building code requiring light and ventilation, and it would maintain the rental value of rear offices which would no longer be shut in by the solid walls of a neighboring structure.

Parking Provisions by Private Enterprise.—But as this phase of municipal service is likely to be slow in developing—though Chicago, for example, is already using part of Grant Park along Michigan Boulevard for parking and Brockton, Mass., has created an open space in the business district for this purpose—and never will meet fully the demand in the present centers of existing cities, there is a large field for private enterprise which would cater to those owners who have the means to pay for service, who wish their car protected from storm and sun when not in use, who need mechanical assistance or who just feel more comfortable when their cars are safe from thieves. To meet this demand a number of methods are now being tried out, ranging all the way from storage buildings several stories in height equipped with automobile elevators, to the use of basements or cellars reached by ramps. Private initiative also has seized upon vacant lots and in some cases the back yards of business blocks and is using these temporarily for automobile parks. What private initiative has here begun, indicates that municipal service can more adequately and systematically do. One rule to use as a guide here is that all such storage or parking spaces should have their entrances and exits—and they should have separate entrance and exit—on side streets or minor streets where the constant crossing of sidewalks by automobiles will least interfere with pedestrians.

But so far as we now know the use of all these methods to the utmost practicable extent will not meet the demand. Washington, which has a larger proportion of its downtown area given up to streets than any other city, which has many downtown streets so wide that cars can be parked at an angle on both curbs, seems to find the parking problem as difficult as other cities. The reason apparently is that the greater parking area results in a greater use of automobiles. It is the antithesis of New York City where in lower Manhattan the very limited parking space almost prevents the use of private cars. That is, the greater parking space puts off the saturation point and thereby benefits the community.

Providing for Trucks.—So far I have had in mind the passenger automobile, not the truck. The latter presents problems peculiar to itself. Except for the small retail delivery truck, its size alone makes difficulty. If parked parallel to the curb it takes up a large amount of space and is placed inconveniently for loading and

unloading. If parked at an angle it projects so far into the roadway and often so far over the sidewalk as to be a very real impediment to traffic.

In towns and smaller cities with their problems of size still in the future, in the still spacious suburbs of big cities, where city planning has today a fairly free field, there is opportunity to provide for future needs. The fundamental evil in our urban centers is the crowding of people too close together. The essential point to bear in mind in our new developments is the value of adequate open spaces. To create great parks and well equipped playgrounds as means of relief for those living huddled together in barrack tenements or packed into suffocating subways is but to give a mild antidote after administering a dose of poison. Human beings need space if they are to live and develop properly. Even in the congested down town areas of our old cities the automobile may have some effect in thinning the population simply by occupying buildings or parts of buildings that otherwise would shelter swarming masses of people. In the suburbs and in the smaller cities they may prevent congestion by reason of the space they occupy.

Parking in Residence Districts.—In residence districts there are at least two considerations which make the situation different from that in business district. Nearly all the differences over which men become excited are not differences of kind, but simply differences of degree, differences of emphasis. Here is such a difference. A business street, the frontage of a business block, is much more a community property than is a residence street, the frontage of a residence block. A citizen or a tourist may have a perfect right, based upon the general good, to park his car in front of your store and leave it there, while he may have no such right to park and leave it in front of your house.

If only an occasional stranger parks his car before your house and does it only on occasional days, the annoyance is so slight that you will probably pay no attention to it. But if the curb in front of your house is constantly occupied by the cars of strangers so that you can not drive up to your own front door and so that your visitors have to leave their cars at a distance; if the starting of motors and the smell of gas constantly wreck your quiet and peace of mind, you have legitimate cause of complaint.

The second consideration which differentiates business district parking from residence district parking, is that in the former parking is nearly always only a day time affair, or, near theatres, an evening affair, while in residence districts, especially in these times of high building costs, it tends to become an all night affair. While admitting the practical difficulties faced by the car owner due to building costs, it should be the rule that all night parking of cars on public streets be forbidden. The owner may not be able to build a garage now, but he should at least drive his car on to his own lot. If he lives in a row house erected upon a lot so small that it contains no space for a car, or if he lives in an apartment house which provides no storage facilities for its tenants, then he is under the necessity of renting garage space somewhere else.

You will have noted that in this discussion there is no suggestion for automobile subways or for double decked streets or for sidewalks raised a story above the roadway. All of these have been suggested in more than one city and in New York such suggestions have assumed very definite form. My belief is that automobile subways would be not only ruinously expensive but that they would be community liabilities in other ways. Double decked streets might cost less to construct but they would be quite as injurious to those who must use the close lower level. An argument may be made for such construction if it is of small extent and undertaken in connection with other improvements, as on South Water Street in Chicago, but this is exceptional. Raised sidewalks would provide a great amount of parking space beneath, but, even assuming that they can be hung on brackets or supported in some other way not necessitating posts or pillars which create a hazard for traffic, they, with the required bridges acros intersecting streets would shadow and darken the roadways and parking spaces below.

Suggestions for Taking Care of the Standing Car.—A generous provision of open streets will prove far less expensive to construct and maintain than would such underground passageways. As a basis for determining what is adequate I would suggest:

On main streets in retail business districts the roadway should be wide enough for a line of cars on each side

arked at an angle of 45 degrees, for line of traffic in each direction and or two trolley car lines. In this case he parked automobiles would be long the curbs. If the street is nough wider to permit two lines of raffic on each side, so that the topping of an autombile for a moment would not halt traffic, the parked utomobiles may be put near the center of the street flanking the trolley ar tracks so leaving the curbs available for discharge of passengers. This lso has the advantage of preventing utomobiles from using the traction ight of way and so impeding trolley ervice. Otherwise it is necessary to eep the traction right of way available for automobile traffic which will ccasionally have to circle about a talled car.

On secondary business streets the vidth should permit of two lines of ars parked parallel with the curb, hough parking parallel is not so good s parking at an angle.

In apartment house districts streets hould be wide enough for parking at n angle.

In one-family house districts there hould be no need of providing for ontinuous lines of parked cars. Unecessary width of roadway means nnecessary cost for the home. It is heaper to park one's car in the yard.

Economic Value of Reducing Highway Grades

The 1922 annual report of E. L. Iiles, county road superintendent of 'ictoria County, Ontario, contains the ollowing interesting item on the conomies of hill cutting:

Our traffic census returns for 1922 how that our provincial county roads re travelled by an average of 140 ehicles per day, 120 being motors nd 20 horse drawn, which we will ssume as correct for a period of 183 ays. For the balance of the year, or 82 days, we are safe to assume this t one-half or 70 vehicles per day. Ve might also safely assume that the raffic on our highways will increase rom year to year at about a rate of 0 per cent.

The average speed of an automobile unning on high gear is four times he running speed of low gear, and he wear and tear on the engine and parts is in about the same proportion.

In the report for 1921, we find that f 4 horses can operate a 6 per cent grade, that it takes 9 horses to operate a 15 per cent grade with the same load, so that the actual difference in the cost is 2¼ times.

Taking the actual cost of operation of the county cars for 1922 at 4¾ ct. per mile and the depreciation value at about the same rate, or a total of about 9½ ct., we have an actual loss of 4¾ ct. for every car that operates a 15 per cent grade on low gear for a quarter mile run. Also if we take the statistical value of the cost to haul one ton—one mile at 4 ct. as given by the Department of Highways, Ottawa, we have a loss of 2¼ ct. every time a horse drawn vehicle operates a 15 per cent grade for a quarter mile run.

So that we find that the economical saving in the operation of 6 per cent grade over a 15 per cent grade is $1,685.10 per year, or that the cost of reducing the Ops-Fenelon Hill at $5,123 is entirely wiped out in 3 years, and the cost of reducing Crawford's Hill at $10,857 is entirely wiped out in 6½ years, not considering the 10 per cent yearly increase in traffic.

Wire Rope Guard Rail in Ontario

In Ontario our timber guardrails were being continually wrecked by cars striking the boards and posts, and many serious and costly accidents occurred where cars plunged completely through the wooden rail. We are therefore using today a ¾ in. wire rope threaded for the full length of the guardrail through the posts, and placed about 18 in. above the ground. If the guardrail is at a particularly dangerous location on a high embankment we use heavy posts and two wire ropes, the lower 18 in. above the ground and the upper 36 in. above the ground. Experience with the wire rope guardrail has shown that a truck or car has not so far gone through the wire rope but the vehicle coming in contact with the rope has been stopped or thrown back on to the roadway. In such a collision one or more posts may be broken but they are easily and cheaply repaired. As an instance of what the public thinks of the wire rope guardrail, we have been thanked for building it and have been told by travellers that the wire rope undoubtedly saved their lives by preventing the car leaving the road. —Extract from paper of Geo. Hogarth, chief engineer, Ontario Public Highways Department, at recent convention of Canadian Good Roads Association.

Development of Apparatus for Field Testing of Roads

A Paper Presented at Last Annual Convention of American Road Builders Association

By H. F. CLEMMER,
Engineer of Tests, Illinois Division of Highways.

In the development of apparatus for field testing of roads, the Illinois Division of Highways has, so far, considered three points which vitally affect

Static Load Bearing Power Determinator.

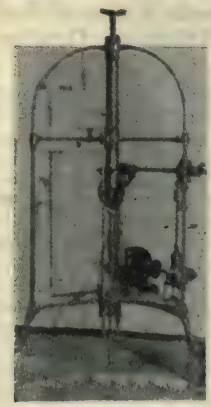
the efficiency and lasting qualities of concrete pavement: First, the bearing power of soil in the subgrade; second, the quality and proper thickness of the slab; and third, the surface irregularities which would produce abnormal conditions of loading. All of these are factors which determine to a great extent the endurance of pavements, and we have endeavored to develop apparatus which will allow a better insight to these three points.

Machines for Testing the Subgrade.—In 1921, in connection with the various tests being conducted on the Bates experiment road, two machines were designed and constructed, one a static load bearing power determinator and the other a repeated load bearing power determinator.

The static load bearing power determinator consists of a three-legged iron pipe frame, from which is suspended a Toledo automatic hanging scale supporting a pail, which contains about 30 lb. of shot. The load is applied to the subgrade by means of a steel rod terminating in a shoe. On the top of this rod is a pan which receives the shot from the apparatus just described. An Ames dial measures the movement of the rod and a thumb screw set in the frame enables the operator to stop the rod at will.

Initial readings are taken with the shoe resting on the subgrade without any load, after which the shot is released and readings are taken for total loads of 10, 20 and 30 lb. Additional readings are taken for 2 minutes at intervals of 30 seconds under the 30 lb. load. The load is then removed and the upward movement of the road is measured.

It has been ascertained that the load distribution on rigid pavements in some cases is as great as 17 ft. In other words, a load on a pavement is transmitted to the subgrade over a definite area. That is, a truck moving

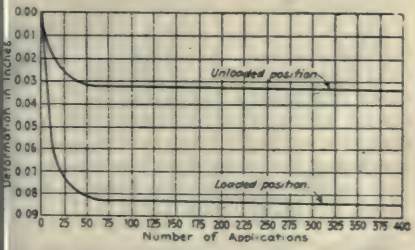


Repeated Load Bearing Power Determinator

down the pavement approaches a certain point, the subgrade at this point is subjected to an increasing pressure which reaches a maximum when the truck is directly over the point. A series of trucks traveling on a pavement surface produces a repeated action such as described above.

Machine for Determining Repeated Load.—The repeated load bearing power determinator approximates this condition of loading. This machine consists mainly of an iron frame in which is mounted a spring for producing pressure. A revolving cam varies the pressure which is exerted upon the soil through a plunger. The movements of this plunger are recorded on an Ames dial. Power for this apparatus is furnished by a unit carried on the same truck as that which transports the machine.

Various other methods of determining the bearing power of soil were



Typical Bearing Power Curve from Determinator Data.

used and checked against the results obtained with the determinator. In practically every case consistent results were obtained which gave further proof that the specially designed apparatus has promise of developing into a valuable aid in subgrade testing.

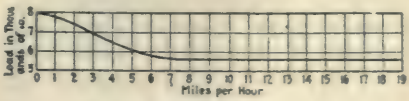
Investigation has proven to a great extent that an ideal subgrade is not necessarily one which has the greatest resistance to deformation from loads but one which not only is fairly firm but is also elastic enough to recover from deformations. The continual movement of the pavement slab due to temperature stresses requires that the subgrade follow it to some extent in order that contact be made. On a perfectly rigid subgrade a slab would soon fail due to the fact that at certain periods of the day the edges alone would be bearing on the subgrade. Then, too, at night when the edges of the slab curl up, a true cantilevered slab would be developed, whereas with an elastic subgrade the tendency would be to follow the slab and form contact with the result that some bearing would be obtained. The repeated load bearing power determinator is so designed that it registers the recovery of the soil when the loads are released and in this way a measure of the elasticity of the subgrade is obtained.

Though very little work has been done with this apparatus except at the Bates road test, it is practical to use the determinator for general field work. Due to its compactness and the fact that the power is supplied by a unit installed on the truck transporting it, it may be used at any location desired. As a means of comparing the bearing power of various soils its value can not be overestimated. Also, the bearing power of the subgrade under any portion of the slab may be determined through core holes in the pavement. This is especially valuable when it is thought that non-uniformity of the subgrade is responsible for certain actions.

Slab Tests with Caly Core Drill.—Though the Division of Highways maintains careful inspection of materials and equally careful inspection of construction, it is believed that a check of the results of this inspection after the pavement has been in service is of value, particularly to study the possibility of improving future construction.

The majority of the pavement is accepted before any investigational tests are made, the engineers being confident that proper work was done. But when there is any doubt as to the proper construction, the final estimate is held up until tests of the slab are made.

The fact that valuable information could be secured after the road was built was realized several years ago at which time the department purchased a Caly core drill with which to make observations. At the time of



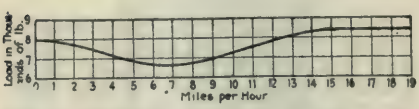
Effect of 8,000 lb. Moving Wheel Load Over Smooth Surface.

the purchase it was felt that an apparatus which would allow the securing of slabs for cross bending tests would perhaps furnish better information than compressive strength specimens due to the fact that the Illinois design depends on transverse strength rather than compressive strength for supporting traffic. This is better understood when it is considered that the present pavement section of Illi-

nois is considered as being designed as a cantilevered slab, support being secured at the center with the edges remaining free. This condition of little or no support at the edges is apparent during various changes of temperatures and also in the fall and spring of the year when the subgrade is saturated with moisture.

A slab cutting apparatus, however, was not available and the best machine to be obtained was the Caly core drill. A machine for cutting specimens, suitable for transverse test, from the finished pavement is much to be desired.

Method of Taking Cores.—At present Illinois has two core drill outfits in operation. One of these machines was secured from the University of Illinois and the other is owned by the Division of Highways. Only one man is necessary to take charge of a core drill outfit and through orders from the Springfield office is able to travel continuously from one district to another. On reporting at the district headquarters the operator is given in-



Effect of 8,000 lb. Moving Load Over ¼ in. Obstruction.

structions as to the location of the pavement from which cores are to be taken. On the average a core is taken every 500 ft. of pavement, the first one being taken about 1 ft. from the edge, the next at the quarter point, the next about 1 ft. from the center joint; continuing in this manner across the entire width of the pavement. In some sections more cores are taken, the number, of course, depending upon whether special investigation is desired.

In conjunction with the taking of a core a check is made of the crown of the road, the object being to determine the correctness of the distribution of the concrete. A straight edge having a level bubble and an adjustable leg is used in taking readings of the cross section of the slab. The readings are taken in line with the point from which the core was removed. The stationary leg is placed on the center line of the slab and the adjustable leg at the edge where it is so set that the straight edge is perfectly level. Readings are taken from the bottom of the straight edge to the surface of the pavement at 2 ft. intervals. At superelevated curves computations are necessary to determine the proper readings. Observations are also taken at the edges of the pavement by digging into the shoulder and measuring the thickness of the slab with a ruler.

After the core is removed it is measured, numbered, located on a sketch and sent into the laboratory. Concrete plugs which are carried in the truck are used in filling up the holes made by the drill. These plugs are grouted in place with mortar and are not noticeable to the public.

When the cores are received in the laboratory they are carefully measured for diameter, capped with cement paste to insure a uniform bearing, and tested for compressive strength in a Riehle machine. After the strength is computed the data with the sketch is sent to the office of the district from which the cores were taken.

Cost of Taking Cores.—Labor is the greatest expense connected with this work. An outfit can take eight to twelve cores a day depending on the hardness of the aggregate in the concrete. About 2 lb. of shot are necessary to drill one core. This shot, known as Calyxite, costs 7 ct. a lb. The cost of the concrete plugs runs about 4 ct. apiece with labor. The total cost of the operation including the taking of cores, placing of plugs, testing of cores for strength, express charges and labor will not run on the average of over 90 ct. per core. Considering the information obtained, this cost can not be said to be prohibitive.

Tests of Surface Irregularities.—Though the Illinois Division of Highways has a clause in its specifications which permits no variation of surface of over ¼ in. in 10 ft. of longitudinal distance, still this ruling was not strictly enforced previous to one year ago and there are some pavements in the state which may be more or less rough. Too, it is sometimes the case that irregularities of surface at the joints or transverse cracks come in after construction or at the end of long service of the pavements. The question of the possible effect of impact caused by such irregularities is one which has been much discussed. A study of the effect of moving loads dropping and mounting obstructions of

arious heights was made at the Bates oad. The effects of the impact blows ere measured in terms of static ading. A friction Ames dial was sed to measure the maximum deflecon of the corner and a specially degned strain gauge was used to deermine the elongation of the upper bres of the concrete. Work was conucted for several months in order hat an efficient check could be had of he results.

It is now intended to construct a pecial corner upon which further ests can be made. Though the inestigation is by no means completed, is evident from the results obtained hus far that it will be possible to pply much of the information obained to the various rigid type pavenents over the state. In other words, f it is thought that a pavement conains a rough spot or an uneven joint, truck carrying the suitable equipnent can determine within reasonable imits the actual loadings imposed on he pavements by moving traffic.

Apparatus for Measuring Upper Elongation of Upper Fibers of Concrete.—In connection with the investigational work conducted by this bureau, a new apparatus is being built to measure the elongation of the upper fibres of concrete. This machine was designed by Mr. Clifford Older, chief highway engineer. It has such a high magnification power that movements of 1/100,000th of an inch can be read. The principle of the apparatus is the reflection of a beam of light from a mirror, set on a shaft of very small diameter, to a scale some distance away. The shaft upon which the mirror is set is so small that with the scale the given distance away, the ratios of the diameter of the shaft and the arc upon which the scale is set allow an enormous magnification of movement. The shaft is the movable point and is attached to the fixed point by a thin copper wire, tension being secured by use of a fine spring. Any elongation of the upper fibres of the concrete will cause movement of the shaft which in turn through the mirror will cause movement of a spot of light on the scale. This light movement is recorded, on a movable film, as a continuous curve of the deformation as the stress varies upon the approach and passage of the moving load.

Gasoline Tax for Road Purposes

According to an article by Noel K. Brown in the July 1 issue of the News Letter of the Wyoming State Highway Department, there are now 32 states that have gasoline tax laws. In 14 states the levy exceeds 1 ct. per gallon, and in three states it exceeds 2 ct.

At the beginning of the year 1923 there were 17 states in which gasoline tax laws were in operation, namely: Arizona, Arkansas, Colorado, Connecticut, Georgia, Kentucky, Louisiana, Maryland, Mississippi, Montana, New Mexico, North Carolina, Oregon, Pennsylvania, South Carolina, South Dakota and Washington. In three of the states named (Maryland, Oregon and South Carolina) the tax was 2 ct. per gallon, and in other states it was 1 ct. per gallon. Since the first of January the legislatures of several of these states have increased the amount of the levy, and the legislatures of many other states have enacted laws providing for a gasoline tax. The following table shows what states have passed gasoline tax laws to date, and the amount of the levy in each state:

State	Tax Per Gal.—Ct.	State	Tax Per Gal.—Ct.
Alabama	2	Nevada	2
Arizona	1	New Mexico	1
Arkansas	3	North Carolina	3
Colorado	2	North Dakota	½ to 1
Connecticut	1	Oklahoma	1
Delaware	1	Oregon	2
Florida	1	Pennsylvania	1
Georgia	1	South Carolina	2
Idaho	2	South Dakota	2
Indiana	2	Tennessee	2
Kentucky	1	Texas	1
Louisiana	1	Utah	2
Maine	1	Vermont	1
Maryland	1	Virginia	2
Mississippi	1	Washington	1
Montana	2	Wyoming	1

In several other states gasoline tax bills are pending in the legislature. In three of the states now levying a 1 ct. tax, provision has been made by law for increasing the tax to 2 ct. at the beginning of the year 1924.

State Highway Work in Ohio.—The work placed under contract by the State Highway Department of Ohio during the past four years has been as follows: 1919, 535,931 miles at a contract price of $15,695,130.39; 1920, 412.167 miles at a contract price of $12,866,119.89; 1921, 393.806 miles at a contract price of $13,774,596.47; 1922, 714.268 miles at a contract price of $21,152,315.80.

Recent Trade Publications

A new bulletin describing its Imperial Type XPV Duplex steam driven air and gas compressors has been issued by the Ingersoll-Rand Co., 11 Broadway, New York City. This type of compressor is built in a number of different types and sizes. Standard two-stage machines for 100 lb. discharge pressure range from 246 to 4,150 cu. ft. per minute piston displacement. Single-stage compressors are built for furnishing air up to 50 lb. discharge pressure.

The Bloomsburg Locomotive Works, Bloomsburg, Pa., has brought out a bulletin illustrating and describing its line of industrial locomotives. These include a gasoline engine driven type, a steam locomotive with vaporizing type burner, and a steam locomotive with the atomizing type burner.

The Asphalt Sales Department of The Texas Company, 17 Battery Pl., New York City, has just printed a 24-page pocket-size booklet on the subject of Texaco cold patch, which describes and illustrates the cold patch method of repairing all types of roads and streets. The booklet gives the proper proportions of stone and asphalt to be used, and takes you right through the entire process, including the mixing and curing of the batch, the preparation of the hole or worn area in the pavement, and the construction of the patch.

Novo air compressor outfits are the subject of a bulletin issued a short time ago by the Novo Engine Co., Lansing, Mich. A feature of the Novo unit is the belt drive. Individual cooling systems have been provided for both engine and compressor and the engine can, if necessary, be used as an independent power plant.

The Waukesha 4-cylinder motors are illustrated and described in a booklet just issued by the Waukesha Motor Co., Waukesha, Wis. The booklet contains specifications of the unit, notes on installation and operation and numerous illustrations showing uses of Waukesha motors on construction machinery and operations.

The Byers Machine Co., Ravenna, O., has brought out a bulletin on its Truckrane. It contains specifications of the crane and describes its many uses in the construction field. Numerous illustrations are included, showing the machine in operation on various construction jobs.

Fellowships in Highway Engineering and Highway Transport

Two of the following Fellowships at the University of Michigan will be awarded not later than Sept. 10, and two not later than Nov. 1, 1923, by the Board of Regents of the University of Michigan:

The Roy D. Chapin Fellowship in highway transport, which is offered to provide for the investigation of an approved subject relative to highway transport.

The Roy D. Chapin Fellowship in highway engineering, which is offered to provide for the investigation of an approved subject relative to hard surfaced roads and pavements.

Two Detroit Edison Fellowships in highway engineering, which are offered to provide for the investigation of approved subjects relative to moderate cost country roads.

General conditons: Each fellowship pays the sum of $250 with an allowance of $50 for expenses. The holders of these fellowships do not have to pay tuition fees. A fellow must hold a bachelor's degree from a college of recognized standing. He must enrol as a graduate student in highway engineering or highway transport and as a candidate for the degree of master of science or master of science in engineering. He must be in residence for one of the following periods: First semester (October to February); winter period (December to March); second semester (February to June). An application for a fellowship must include a concise statement of the candidate's educational training and engineering experience, and three references. Applications and requests for information pertaining to the 25 advanced courses in highway engineering and highway transport offered by the graduate school should be sent to Professor Arthur H. Blanchard, Engineering Building, University of Michigan, Ann Arbor, Mich.

$31,500,000 Spent in Iowa in 1922 on Roads.—Iowa spent in 1922 for road work and bridges on the 104,000 miles of public highway $31,552,000. Of this total primary road expenditures on 6,615 miles were $13,858,727; county road expenditures on 10,890 miles were $4,255,371; township road expenditures on 86,595 miles were $6,048,746. Bridge and culvert expenditures on all three systems totaled $7,389,529.

Water Works

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.
221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*
LEWIS S. LOUKE, *Vice-President and General Manager*
New York Office: 904 Longacre Bldg., 42d St. and Broadway
RICHARD E. BROWN, *Eastern Manager*

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Vol. LX. CHICAGO, ILL., AUGUST 8, 1923 No. 2

President Harding

As Americans we mourn the death of our President. As engineers and constructors we regret the loss of a chief whom we knew to have at heart the wise and substantial development of industry, commerce and native resources. As men among men we feel that there has gone from a high place a brother of sterling character.

For many reasons we admired Mr. Harding, and we are not concerned over the verdict that history in due time will pass upon him. Whether he was greater or less than this or that predecessor; whether in his own time he filled his office better or worse than some other would have done, are not matters of present moment, nor questions that can be satisfactorily settled, for of necessity, the answers to such questions are largely but personal opinions.

The facts are that he was confronted with problems of tremendous and unusual difficulty, even for presidential problems; that for their solution he gathered together a cabinet of unquestionably great ability; that he heeded the advice of cabinet members and experts without subserviency thereto; that he believed in himself and his mission, but never posed as a super-man; that he was kindly and human; and that his country's welfare transcended every other motive within him.

Our beliefs are that his acts in office were for the most part well directed; that his mistakes were fewer than might reasonably have been expected in the complications of the past thirty months; that his policy of leadership rather than of domination was wise and practical, and represented the true intent and spirit of American government.

President Harding's unquestioned interest in a progress which is bound up with engineering brought him close to the profession; and his economies in governmental expenditures deserve the admiration of those whose function has so often been stated as the doing of things at a minimum of cost.

President Coolidge has stated his intention of pursuing the policies of his predecessor, but his past record is a guarantee that such pursuit will be no blind imitation. America looks to him with a warrantable hope that he will not only keep the good that has been left him, but that he will add to it from his own store.

Increasing Fuel Efficiencies

"A kilowatt-hour for a pound of coal"—once looked upon by many hard headed power producers as extremely improbable, if not hopeless—now appears to be within grasp. We say "appears to be," for although reputable steam technicians have expressed their full confidence that the attainment is a matter of but a brief time, it is well to wait for a thorough demonstration on a commercial scale before acclaiming the triumph.

Elsewhere in this issue we print a brief, non-technical account of the way in which it is expected to reach this goal through the use of pressures up to 1200 pounds, or perhaps as in the case of a British experimental plant mentioned, up to the enormous pressure of 3200 pounds. It is declared that materials now available have all the properties necessary for use in machines operating at such pressures and the very high temperatures incident thereto.

Another line of experiment in the development of higher efficiencies is in the use of two distinct liquids of different vaporizing temperatures, the higher vaporizing liquid being used first and its exhaust employed to boil the other liquid. Report has it that installations using water as the material of higher vaporizing temperature and carbon disulphide as the lower are already in successful operation in Germany. In our own country an experiment is actually under way with mercury as the higher and water as the lower vaporizing liquid.

It is in such ways that progress is being made. The rate is tremendous, and discoveries and developments fail to be sensational only because of our habituation to them. Failures there must be in great numbers—failures at least as to the specific goal immediately sought—but there is hardly an experiment undertaken and prosecuted seriously that fails to develop some worth-while fact.

Pioneers

The suggestion of 3200 pound steam pressures awakens thoughts which, though far from new, may well from time to time be reiterated. The world is dull only as our minds are dull.

The days of pioneering and development are still here—in fact always will be here for those who will keep their imaginations active. The squirrel rifle and the coon skin cap, the six-shooter and chaps have been succeeded by no similarly conspicuous badges of pioneering. Youth thinks with envy of their wearers. Maturity grants admiration but also sees the pioneer's satisfaction in many an inconspicuous business or professional man who has dared to venture into new fields of thought and activity.

To the adventurous spirit the unknown still beckons through politics, sociology, economics, science, art; nor does its pursuit lack the thrill of danger. Disappointment, poverty, loss of prestige—all may be in store for the man who departs from beaten paths, but thank God there are still those who find the hope of achievement worth every risk as did the land pioneers of other days.

Price of Portland Cement

A chart prepared for the Cement Information Service covering the last four years and the first six months of this year shows that the price of Portland cement is far below the peak reached in 1920 and has been practically unchanged since last September.

On this basis, the average wholesale price of Portland cement for June is $1.892 per barrel, exclusive of bags. In the period covered by the chart cement declined from $2.22 per barrel in the latter part of 1920 to $1.70 in the early part of 1922. Since that time there has been an advance of less than 19 cents per barrel or 10 per cent, as compared with an advance of approximately 49 per cent in building materials in general.

The average yearly price received by all cement producers for the past 40 years, according to the Geological Survey, is $1.505 per barrel. The present wholesale price as shown by the Bureau of Labor Statistics is therefore only about 25 per cent above the average yearly price for the past 40 years.

Water Works and Sewer Contracts Awarded During the Last 42 Months

'he accompanying tables show: st, that the waterworks and sewer tracts awarded during the last half each year exceed in volume those arded during the first half; second, t there is not a month in the year hout a very large volume of water-ks and sewer contracts; third, that each year shows a gain over its predecessor in the volume of contracts awarded in this "hydraulic field."

The volume of irrigation and drainage contracts will surprise any one who has not followed closely statistics of this sort.

WATERWORKS CONTRACTS EXCEEDING $25,000 IN SIZE.

	1920	1921	1922	1923
uary	$ 1,144,000	$ 519,000	$ 1,727,000	$ 4,720,000
uary	2,172,000	2,927,000	652,000	2,730,000
ch	2,213,000	2,028,000	1,093,000	15,149,000
l	2,719,000	3,342,000	2,673,000	8,544,000
	1,382,000	4,944,000	3,568,000	7,329,000
e	1,461,000	3,485,000	5,124,000	4,045,000
	3,793,000	3,106,000	811,000	———
ust	775,000	2,404,000	4,494,000	———
ember	743,000	1,487,000	3,906,000	———
ber	11,169,000	900,000	7,686,000	———
ember	2,151,000	4,698,000	2,161,000	———
ember	1,051,000	10,752,000	1,835,000	———
Total	$30,773,000	$40,602,000	$35,730,000	———

Note.—About 100 per cent must be added to the annual totals to give the grand total of racts awarded in the United States.

A great deal of waterworks construction is done by directly hired labor and is not included n.

Waterworks buildings are not included above.

SEWER CONTRACTS EXCEEDING $25,000 IN SIZE.

	1920	1921	1922	1923
uary	$ 1,364,000	$ 3,147,000	$ 2,267,000	$ 3,322,000
uary	623,000	2,445,000	2,462,000	2,131,000
ch	1,283,000	2,862,000	3,796,000	4,477,000
l	4,124,000	3,817,000	2,794,000	5,497,000
	2,315,000	2,162,000	5,722,000	9,052,000
e	2,349,000	3,802,000	5,158,000	6,501,000
	3,163,000	3,986,000	1,869,000	———
ust	2,437,000	3,988,000	3,450,000	———
ember	2,319,000	5,064,000	3,340,000	———
ber	8,052,000	2,829,000	4,996,000	———
ember	4,572,000	2,733,000	5,349,000	———
ember	2,967,000	2,549,000	2,381,000	———
Total	$36,068,000	$39,384,000	$43,584,000	———

Note.—About 100 per cent must be added to the annual totals to give the grand total of racts awarded in the United States.

A considerable amount of sewer construction is done by directly hired labor, which is not uded in the above totals.

IRRIGATION, DRAINAGE AND EXCAVATION CONTRACTS EXCEEDING $25,000.

	1920	1921	1922	1923
ary	$ 1,542,000	$ 1,266,000	$ 2,091,000	$ 548,000
uary	787,000	306,000	419,000	$65,000
ch	3,151,000	1,626,000	608,000	28,993,000
l	416,000	580,000	1,736,000	2,506,000
	404,000	2,632,000	776,000	3,553,000
	605,000	1,240,000	2,628,000	1,174,000
	1,942,000	609,000	1,498,000	———
ust	4,179,000	89,000	6,920,000	———
ember	859,000	9,025,000	876,000	———
ber	1,086,000	373,000	2,390,000	———
mber	772,000	726,000	1,741,000	———
mber	477,000	707,000	864,000	———
Total	$16,220,000	$19,179,000	$22,547,000	———

Note.—About 100 per cent must be added to the annual totals to give the grand total of racts awarded in the United States.

The O'Shaughnessy Dam of San Francisco

341 ft. Structure Formally Dedicated on July 7

The O'Shaughnessy dam, the largest undertaking of the Hetch Hetchy project of San Francisco, one of the most notable municipal water supply developments in the country, was formally dedicated on July 7. This project, it will be remembered, is a plan for a municipal water supply, evolved by the city and county of San Francisco, for the collection and storage of waters of the Tuolumne River and its tributaries near their sources in the Sierra Nevada Mountains, and the transmission of those waters across the San Joaquin Valley and through the Coast Range of of mountains for delivery to the city of San Francisco and its environs; due advantage being taken of appropriate drops in the conduit routes for the generation of the maximum quantity of hydro-electric power which can thereby be economically developed.

The dam is of the arched gravity type and is 341 ft. in height from the bottom of the foundation to the present crest the foundations have been built strong enough to enable the dam to be carried to a height 85 greater, which will increase stora capacity 50 per cent. The pres capacity is 66 billion gallons.

To accomplish this work it w necessary to construct four auxili dams, one on the upstream side divert the main river into the tunn one on the downstream side 1,000 f below to stop flood water from ba ing into the excavation, and as t excavation progressed it was nec sary to build two auxiliary dams, o immediately above the excavation a one below, before the pouring of co crete was undertaken in the ma foundation.

View taken June 7, 1923, of the O'Shaughnessy Dam of San Francisco.

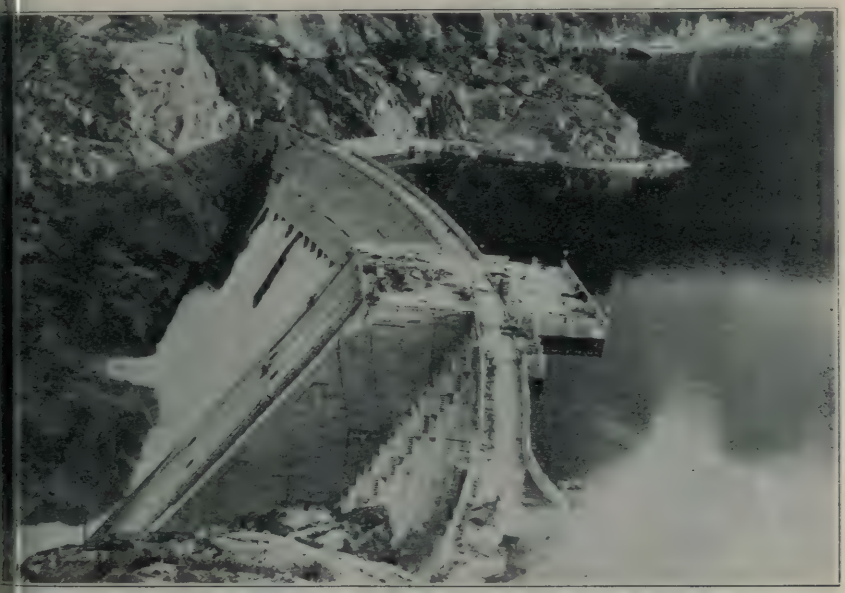
The whole floor of the valley w entirely cleared of timber in two op ations, the first in 1915, when all t lower portion of the valley w cleared of timber, and the second 1921-22, when the remainder of t reservoir basin was cleared.

The dam, built in the shape of arch, with a 700 ft. radius, at the b tom of the foundation is at elevati 3386. The bottom valve elevation 3508, and the initial crest elevati

300 ft.; the storage capacity, 66 on gallons; drainage area is 294,- acres, and the reservoir area is 0 acres. The total volume of con- e is 398,976 cu. yds., and the ex- ation required amounted to 207,- cu. yds. The dam was constructed the Utah Construction Co., the re contract estimate was $6,114,- The contract price for valves e in San Francisco, Philadelphia Boston was $532,707, which es a total of $6,647,355.

he dam was designed by M. M. haughnessy, City Engineer of San ncisco, and very fittingly by ac- of city and county it has been cially named after him.

A few words regarding the progress the other works of the Hetch Hetchy Project may not be out of ce. At a point 12 miles below the n, at Early Intake, has been built main aqueduct, practically 20 es in length, between Early Intake Moccasin Creek. All but 4,000 of tunnel has been excavated on s work. It is programmed to have finish lined with concrete within months, when the power house be all equipped, ready for serv- This will develop about 300,000,- 000 kilowatt hours. Practically 70,- 000,000 kilowatt hours will furnish the City's immediate needs for street lighting and driving the municipal railways. There are possibilities for developing over a billion kilowatt hours of power still on this project, one by building a tunnel from Hetch Hetchy to Early Intake and putting in a power house at that point, which will develop possibly 80,000 hydro horsepower, another by building a high line canal from Eleanor to above Early Intake which will develop 40,- 000 hp. Other possibilities for power may be developed on the higher Cherry and other reaches of the City's watershed.



O'Shaughnessy Dam of the Hetch Hetchy Water Supply Project of San Francisco, Calif.

The Bay Division of the project between Irvington and Crystal Springs reservoir, about 22 miles in length, is in a very forward condition. The Pulgas Tunnel, through the Coast Range of hills, 8,700 ft. long, will be bored through inside of a month or so and contract has been let for 21 miles of steel pressure pipe by which water from Calaveras and Niles Canyon can be brought across the bay at Dumbarton and placed in Crystal Springs Reservoir.

The New Well Water System of Camden, N. J.

By JAMES H. LONG
Maintenance Engineer, Water Department, Camden, N. J.

The water supply problem which Camden, N. J., had to solve was by no means an easy one.

We had two pumping stations. One station secured 17,000,000 gals. per day from 98 shallow wells, while the other had 25 wells for its supply of 5,000,000 gal. per day. These wells were spread over several acres of ground and it was out of the question to put down any more wells without disturbing the yield of the existing ones. Our equipment at that time comprised a combination of steam suction pumps, air compressors and horizontal centrifugal units driven by electric motors. Unfortunately our stations were located seven miles from the city so that the water pressure was very appreciably decreased when it reached the consumer. To be specific, the water was pumped into the mains at a pressure of 50 lb., ar in the city the pressure was 25 l Three years ago we were confronte with this problem: (1) equipme and wells working at maximum capa ity, (2) 50 per cent of the pressu lost in the mains, (3) consumers di satisfied.

We arranged with the Layne-Ne York Co. of New York City, an ass ciate company of the Layne & Bowl Co. of Memphis, for a survey by o of its engineers. The chief engine of the Layne-New York Co. made t investigation and submitted to us proposition along the following line

The Layne New York Co. guara teed to the City of Camden a max mum production of 6,000,000 gal. p day, and a minimum production 4,000,000 gal. per day. To back their guarantee a bond was plac with the city for the full value of t contract.

The work started. One element the installation I desire to mention the Layne gravel wall well, which me was a novel feature in well co struction. A Layne shutter scree

Fig. 1

was placed in the ground opposite the water bearing sand formation; a test pump was placed in the well and the water and sand pumped out in large volume. As the sand was pumped out the gravel was fed in from the top so that the gravel gradually replaced the sand. This formed a gravel wall around the shutter screen which served as a filter, kept the sand out and gave more area for the reception of water into the well.

The wells were completed and tested—Fig. 1 shows well No. 1 being tested and yielding at the rate of 1,500,000 gal. per day. The four pumping units when completed, gave us 6,500,000 gal. per day at a pressure of 40 lb. These stations were placed in the city and pumped the water directly into the mains so that the pressure was raised from 25 lb. to 40 lb.

It should be kept in mind that these improved conditions were made without replacing the mains or adding to them in any way. In addition it was found that the saving in fuel which we made at the main pumping stations, seven miles out of town, paid for the power and the attendant at the new station. The actual power consumed was guaranteed by the Layne New York Co. not to exceed 1.1 KW per 1000 gal. Upon test this was found to be only .83 KW.

Each pump house was of the same design—brick construction with a white interior finish, and an interior view of one of the houses is shown in Fig. 2. A small switch board for the vertical motor contained an oil switch with overload relays, under voltage release and the electrical meters.

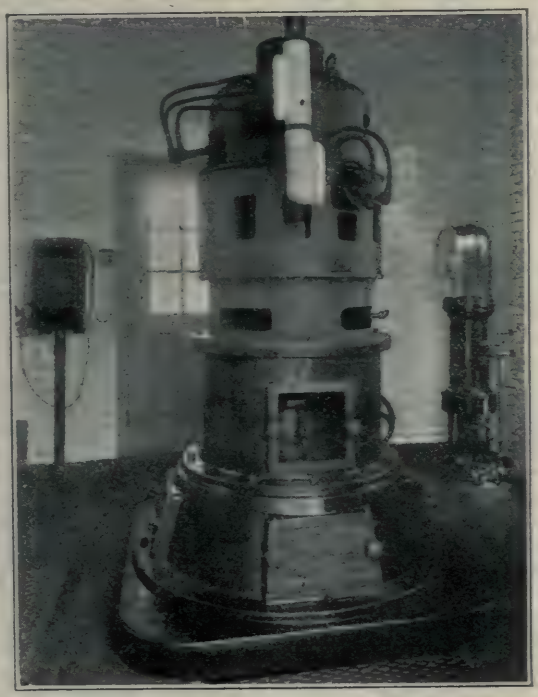


Fig. 2

One arrangement which I liked particularly was that a Venturi meter and a KM meter were placed in each house so that by looking at the Venturi meter I could tell if the required amount of water was being pumped into the mains, and by noting the KW meter I knew if the motors were functioning properly. The meters for both the water and electricity were complete in every detail, and in fact we feel that the whole installation could not be improved upon in any way.

Drag-Line Excavation Operation on Irrigation Project

The U. S. Interior Department is carrying on extensive construction work on the North Platte irrigation project in the states of Nebraska and Wyoming in connection with excavation of canal and drainage systems, and has excavated to date over 30,000,000 cu. yd. of material. During 1922 over 2,500,000 cu. yd. of material have been moved in connection with this work.

In connection with this work a large number of electric drag-line excavators are in operation, and in cooperation with the manufacturers there have been perfected types of excavating machines with which the department has been able to make excellent records of economy and efficiency. We are indebted to an article by L. G. Cairns in the June Reclammation Record for the following details:

Machine No. 43, a class 9½ electric drag line excavated between July 8, 1919, and June 24, 1922, approximately 1,300,000 cu. yd. of material, of which 17 per cent was class 2. The machine was operated continuously two shifts per day except when temporarily delayed by storms or other causes for which the machine was not responsible without losing two consecutive shifts on account of repairs.

Two class 9½ electric drag lines, Nos. 12 and 43, working two shifts per day on the Fort Laramie main canal, excavated 790,747 cu. yd., of which 24 per cent was class 2 material which required blasting. The average excavation per machine per month was 42,900 cu. yd. The average per shift, including repair shifts. was 805 cu. yd. In addition to the 790.747 cu. yd., there were rehandled 25,270 cu. yd. on account of very heavy cuts.

During the month of June, 1922, the record for the two above-mentioned machines working two shifts per day was as shown in the accompanying table.

During August, 1921, five class 9½ electric drag lines on a two-shift basis excavated 212,643 cu. yd., or an average of 42,500 cu. yd. per machine.

In December, 1921, four class 9½ electric drag lines working two shifts per day excavated 174,060 cu. yd., or an average of 43,500 cu. yd. per machine.

The average excavation per machine per month of the class 9½ electric drag lines on the Fort Laramie division, working two shifts per day, was 33,600 cu. yd. for the 152.5 machine months.

Electric drag line operation, June, 1922:

Item	No. 12	No. 43
Excavation, class 1, cu. yd.	48,060	52,393
Excavation, class 2, cu. yd.	11,276	10,435
Total	59,336	62,828
Number of shifts, including Sunday repairs	56 6/8	57
Average cu. yd. per shift	1,043	1,104
Number of shifts, digging time	52	50
Average cu. yd. per shift	1,140	1,256
Cu. yd. per hour, digging time	165	182
High run in 8 hours, cu. yd.	1,867	1,886
High run in 16 hours, cu. yd.	3,422	3,671
Lin. ft. of drain	5,477	6,260
Bottom width, ft.	24	24
Depreciation, cost per cu. yd.	$0.0485	$0.0478
Operating cost per cu. yd.	.0245	.0274
Total field cost per cu. yd.	.0730	.0752

Both high runs made on June 21.

As an example of the adaptability of the drag-line excavators to other work, it is interesting to note that during the excavating of drains over which pile bridges were constructed the piles for bridges were driven by the drag-line excavators after excavation had been completed to the level at which the piles intersect the slope line. Adjustable leads were attached to the boom for driving these piles and this permitted their removal before moving to a new location without raising or lowering the boom. About five hours were lost from the excavation work in driving 8 or 10 piles, and the cost of labor, including car mileage, was about $16.

During the month of May, 1923, a class 9½ electric drag line using a 1½ cu: yd. bucket and operating three shifts, excavated 117,413 cu. yd. of practically all class 1 material at a field cost of 3½ ct. per cu. yd.; high run in 8 hours, 2,358 cu. yd. high run in 24 hours, 6,215 cu. yd.; average per operating shift, 1,480 cu. yd.; average per shift, including Sunday repairs, 1,358 cu. yd. In the period from May 21 to May 31 the machine excavated 46,155 cu. yd. The machine practically lost 3½ shifts moving to new work and crossing a canyon.

During the month of May 253,447 cu. yd. were excavated by drag line at a field cost of 5.6 ct. per cu. yd.

Water Wastes, Meters and Rates at Baltimore

A Comprehensive Study and Analysis Based on Surveys Covering Present Conditions, Anticipated Results, Financing Problems and Installation Details in a Review Presented to the Engineers' Club of Baltimore, March 28, 1923

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To be Published Serially in Engineering and Contracting

Part I—Wastes, Waste Surveys and Meters

Chapter I

Water Wastes and Waste Surveys.—The Water Department of the City of Baltimore is at present conducting two waste surveys in an endeavor to prevent a further increase in the average daily consumption of water and to eventually reduce the quantity now used. Practically every citizen knows of the house inspectress who at one time or another has in the course of her duties visited his home to determine if any leakage exists on the various plumbing fixtures found in every household.

House Inspection.—This work was begun some four or five years ago during the period of the World War, women being employed because of the inability to secure men for this work, the nucleus of the organization being a group of women formerly employed by the Street Cleaning and Health Departments. Others have been added, some experienced in the work, some without previous training, until the original corps of six has now increased to an average during the past year of sixteen inspectresses.

All readers may not be familiar with the fact that the local distribution system of Baltimore is divided into three zones, commonly referred to as High, Low and Middle Services. Low Service is fed by a gravity supply from a covered reservoir located at the Montebello Filtration Plant, which also serves as suction for the pumping stations supplying the Middle Service zone. Water for the High Service zone is repumped, being litted from a Middle Service Reservoir in Druid Hill Park to the Arlington and Roland Park Standpipes.

High and Low Service Defined.—It is a common fallacy to assume that High, Low and Middle refers to the pressure available, i. e., that High Service is somewhat analogous to the High Service system of the Fire Department. This is entirely wrong. The purpose of the three zones of distribution is to equalize the pressure and to provide a service to consumers located at high points, equivalent to that received by those consumers adjoining the water front. If one drew a line from, say, Wilkens Avenue and Caton Avenue to North Avenue Bridge and then eastward on North Avenue with a deviation southward at some points to Biddle Street, then all the area south and east of this line would be in Low Service. About two-thirds of the entire consumption of the City is absorbed by this district. The term "Low" is applied because of the topography, the elevation varying between 0 ft. and 100 ft. A.M.T.

Conversely, High Service refers to the northwestern and northern suburbs—Windsor Hills, Forest Park, Arlington, Ashburton, and the various developments contiguous to the Green Spring Road-Guilford development. The boundary of this area begins in Irvington, runs northeastward to the Gwynns Falls, to North Avenue and skirting the northern side of Druid Hill Park, continues eastward past Homewood and the area north of the new Venable Stadium. This territory,

Table I—Results of Pitometer Survey

District	Area Sq. Miles	Population	Length of Mains Miles	Water Saved G. P. D.	Value @ 65c per 1,000 cu. ft. yr.	Cost of Survey
1	0.95	55,369	40.29	2,003,200	$63,575.50	.....
2	1.87	30,179	42.43	2,628,800	82,460.60	.....
3	2.66	54,769	52.08	1,535,100	49,756.73	$8,199.15
4	0.54	28,507	27.34	825,220	26,613.97	3,805.20

although it is extensive, consumes but little water, as it is not entirely developed and consists almost entirely of detached suburban houses, about two percent of the total consumption being here used.

Middle Service, the intervening strip between the High and Low Zones of Distribution, stretches diagonally across the center of the city, between elevations 100 ft. and 250 ft. A.M.T. This zone of distribution consumes about thirty-one percent of the City's entire demand.

Inspection Periods and Procedure.—Although the foregoing has appeared somewhat of a digression, it was necessary to explain the subject in connection with waste surveys. The entire city was formerly inspected once a year, however, with the force available the past two years, inspections have been made somewhat more in ratio with the consumption; that is, Low Service is inspected three times, Middle Service, twice, while the houses in High Service are inspected but once each year. This is a far more logical arrangement.

An inspectress is given at the beginning of the day's work a book showing the route which she is to follow in inspecting a certain designated area. Entering a home on the list she is to apply an aquaphone (a sound amplifier resembling a telephone receiver) to the nearest plumbing fixture and to determine by the sound if any water is running on the premises. If everything appears satisfactory she proceeds to the next location. If it appears, however, that waste is being allowed an inspection is made of every fixture in the house and, if necessary, a notice served upon the occupant requiring repairs to be made within seven days. Upon the expiration of this period another inspection is made by an inspector who if he does not find the trouble eliminated, orders the water turned off at the curb stop.

Classification and Percentages of Leakage.—The total leakage eliminated in the course of each pitometer survey is divided into underground leakage — waste on water mains, water supply service pipes, etc.—and housewaste, under which category is placed all forms of waste originating within the curb stop. With surprising consistency we have found that house waste represents about forty per cent of the total leakage. This waste is due entirely to the carelessness of the householder, as the city charges him merely a flat rate and the only check upon his consumption is house inspection. If meters were installed and all water used paid for we are confident that this house waste would be stopped. In other words

Table II—Consumption Data by Pitometer Districts

Pitometer Dist. and Sec.	Population	Aver. Daily Total Consumption (Gallons)	Aver. Daily Metered Consumption (Gallons)	Aver. Daily Domestic Consumption (Gallons)	Aver. Daily Per Capita Domestic Consumption (Gallons)
District 1 (6 sections)	55,359	7,700,800	2,383,800	5,517,000	99
District 2 (5 sections)	30,179	9,576,300	3,965,000	5,611,300	186
District 3 (8 sections)	54,768	8,214,200	3,612,571	4,601,629	84
District 4 (4 sections)	28,507	3,947,000	1,633,358	2,313,642	81
(District 4 is chiefly residential in character.)					
Pitometer Sections Where Consumptions Are Principally Domestic (Unmetered)					
Character of Dwellings (from Insurance Atlas)					
Dist. 1					
Sec. 2 14′-20′ front	8,186	891,000	109,800	781,200	95
Sec. 4 14′-20′ front	9,240	1,265,000	396,000	869,000	94
Sec. 5 *12′-15′ front	22,110	3,138,000	1,238,000	1,900,000	86
Sec. 6 *12′-15′ front	4,663	360,000	none	360,000	77
Dist. 2					
Sec. 3 15′ front	15,530	1,399,000	6,000	1,393,000	89
Sec. 4 *12′-15′ front	5,525	760,000	301,000	459,000	83
Dist. 3					
Sec. 2 *12′-15′ front (many small houses in alleys)	3,863	264,500	14,065	250,435	67
Sec. 4 *For analysis see Table 2	4,660	607,500	233,900	373,600	80
Sec. 5 *12′-15′ front	8,385	940,800	259,400	681,400	81
Dist. 4					
Sec. 1 *12′-20′ front (alleys inhabited)	10,035	907,000	122,440	784,560	78
Sec. 2 *12′-25′ front (alleys inhabited)	11,228	1,080,000	303,215	776,785	70

*Note the coincidence that the per capita domestic consumption tends to remain below 85 in sections having many small houses, and congested alley inhabitants.

almost one-half of all the water now being wasted would be saved if meters were installed.

Leaks occurring in streets and highways are visible and arouse comment, but it is difficult to believe that these seemingly large sources of waste are almost equaled by the numerous small leaks hidden within the homes of the city. This, however, has been demonstrated again and again. The most serious waste of water is caused by leaking toilets, the construction apparently being favorable to unobserved or uncared-for leakage; spigots come second in the quantity of water wasted, although in number they far exceed any other form of waste. Leaking hoppers are also frequently encountered.

The above are all plumbing fixtures, but miscellaneous waste of water is being continually found. The non-automatic cellar drainer, the water motor, the washing machine operated by water, the troughs of running water where poultry is kept, and other uses to which water may be put, aside from legitimate purposes, are all encountered. All of these factors may appear negligible, but the summation thereof creates values which must be given consideration.

Inspection Costs Per Leak and Per House.—The three types of leaks are spigots, toilets and hoppers, and are classified as "slight", "medium" or "bad", according to the quantity of water escaping. During 1922 the cost per leak varied on a yearly basis from $0.22 and $0.29 for the two most proficient inspectresses to $1.03 and $1.05 for an inspectress of a directly opposite type. For the entire corps the cost averaged $0.055 per house visited and $0.49 per leak located. Yearly averages are given, as the time of the year, the character of the district and the state of the weather all combine as influencing factors.

It is believed that house inspection is not actually decreasing the daily consumption but has fulfilled that function and is more of a deterrent upon further increase. This view is substantiated by the fact that very few "bad" leaks are encountered; the great majority being "medium" or "slight". The general public has come to appreciate the true meaning of this work and is beginning to cooperate to the fullest extent. Baltimore is popularly known in other cities as the home of white marble steps, the belief being that the average housewife spends most of her time in washing, getting ready to wash, or looking to see if these ornaments to her home need washing. It appears that in certain portions of the city it is now as much of a social stigma to have one of our inspectresses leave a leak notice as it is to have the marble steps in need of laundrying. Civic pride can go no farther. To have secured this sense of cooperation is particularly gratifying to the Department.

Pitometer Surveys. — The second waste preventive is the pitometer sur-

Table III—Analysis of the Domestic (Unmetered) Consumption of Section 4—District 3 Pitometer Survey

(An average section of those considered.)

Boundaries: Columbia Ave. and Green St. to Lombard St., to Fremont Ave., to Hollins St., to Poppleton St., to Columbia Ave., to Green St.

Width of House	No. of Houses	Present Rate	Present Revenue	Population	Persons Per House	Aver. Daily Consumption (Gallons)	Aver. Daily Per Capita Consumption (Gallons)	Aver. Daily Consumption Per House (Gallons)	Revenue To be Obtained After Metering 50 Gal. Per Capita
Under 12′	351	$ 3.25	$1,140.75	1,547	4½	123,960	80	353	$ 5,408.91
12′-13′	148	5.00	745.00	671	4½	54,080	(constant)	363	2,286.09
13′-14′	166	6.50	1,079.00	830	5	66,400	.....	400	2,719.08
14′-15′	74	7.50	555.00	405	5½	32,400	.....	437	1,284.64
15′-16′	79	9.00	711.00	395	5	31,800	.....	400	1,294.02
16′-17′	17	11.50	195.50	104	6	8,320	.....	490	311.61
17′-18′	31	15.50	480.50	199	6½	15,920	.....	513	598.30
18′-19′	10	17.00	170.00	75	7½	6,000	.....	600	208.60
19′-22′	33	19.50	643.50	303	8	24,240	.....	734	797.61
22′-25′	10	22.00	220.00	82	8	6,560	.....	656	222.20
25′-30′	2	25.00	50.00	24	12	1,920	.....	960	60.02
Special Rate 13′-14′	3	5.00 +extras	31.50	25	8	2,000	.....	666	66.66
Total	925*	.....	$6,021.75	4,660	.....	373,600	.....	.....	$15,267.74
Average	....	.....	.....	.....	5	.....	80	400	.....

*Note: 740 houses have a front footage of 15′ or less.

vey now in progress, and which was inaugurated in the summer of 1920. Previous to this, however, much pitometer work had been done, but owing to the war and the ensuing curtailment in the number of employees it was necessary to abandon the work. The present survey is larger in the scope of its operations and work of a more minute and scientific character is being accomplished.

For the same reason that more frequent house inspection is made in Low Service, all measuring activities are confined at present to this zone. For facility in measuring, entire Low Service has been divided into a number of areas known as districts, which have been sub-divided into sections—the units measured at an operation. To date, four districts totaling twenty-four sections have been surveyed.

Waste Prevention Not the Greatest Benefit from Surveys.—Pitometer surveys are usually considered to be conducted for the sole purpose of saving water, i. e., to reduce the daily consumption with whatever financial gain that may imply. Although locally the survey was inaugurated primarily for this purpose, it has been our experience that the greatest value of the work has been in other fields. The close examination of the distribution system required by pitometer surveys permits of much maintenance work which would otherwise be left undone. Aside from detecting broken valves and underground leaks, the survey eliminates many minor matters which, though in themselves of small importance, combine to lower the efficiency of the distribution system and to greatly increase the cost of maintenance.

Procedure and Methods. — The procedure followed is to completely isolate the section being measured and to supply water through one main, the flow on which is recorded.

Table IV—Population, Per Capita and Average Daily Consumption

		Average Daily Per Capita Consumption—Gals.									Average Daily Cons.—Million Gals.		
		Unmetered					Metered 10 Yrs.		Metered 15 Yrs.				
Year	Population (1)	Public (2)	Waste (3)	Commercial (4)	Domestic (5)	Total (6) 2+3+4+5=6	Domestic (7)	Total (8) 8=2+3+4+7	Domestic (9)	Total (10) 10=2+3+4+9	Unmetered (11) 11=1×6	Metered 10 Yrs. (12) 12=1×8	Metered 15 Yrs. (13) 13=1×10
1906	546,000					123.50					67.43		
07	550,000					128.00					70.40		
08	559,000					126.00					70.43		
09	563,000					122.40					68.91		
10	570,000					115.79					66.00		
11	577,000					117.85					68.00		
12	583,000					123.50					72.00		
13	590,000					125.42					74.00		
14	596,000					120.80					72.00		
15	601,000					121.46					73.00		
16	608,000					125.00					76.00		
17	613,000					141.53					86.76		
18	620,000			34.60		174.35					108.10		
19	626,000			35.00		170.68					106.84		
20	632,000			35.70		154.79					97.83		
21	640,000			35.30		138.97					88.94		
	750,000	10.00	13.00	34.45	66.50	123.95	66.50	123.95	66.50	123.95	92.96	92.96	92.96
22	760,000	10.00	13.00	34.60	67.95	125.55	65.81	123.41	66.52	124.12	95.42	93.79	94.33
23	770,000	10.00	13.00	35.00	69.40	127.40	64.91	122.91	66.40	124.40	98.10	94.64	95.79
24	780,000	10.00	13.00	35.30	70.85	129.05	63.79	122.09	66.14	124.44	100.66	95.23	97.06
25	790,000	10.00	13.00	35.70	72.30	131.00	62.45	121.15	65.73	124.43	103.49	95.71	98.30
26	800,000	10.00	13.00	36.20	73.75	132.95	60.90	120.10	65.18	124.38	106.36	96.08	99.50
27	810,000	10.00	13.00	36.75	75.20	134.95	59.14	118.89	64.49	124.24	109.31	96.30	100.63
28	820,000	10.00	13.00	37.40	76.65	137.05	57.16	117.56	63.65	124.05	112.38	96.40	101.72
29	830,000	10.00	13.00	38.20	78.10	139.30	54.96	116.16	62.67	123.87	115.62	96.41	102.81
30	840,000	10.00	13.00	39.00	79.55	141.55	52.55	114.55	61.55	123.55	118.90	96.22	103.78
31	850,000	10.00	13.00	39.90	81.00	143.90	49.93	112.83	60.28	123.18	122.31	95.91	104.70
32	860,000	10.00	13.00	40.80	82.45	146.25	50.68	114.48	58.87	122.67	125.78	98.45	105.50
33	870,000	10.00	13.00	41.80	83.90	148.70	51.43	116.23	57.32	122.12	129.37	101.12	106.24
34	880,000	10.00	13.00	43.00	85.35	151.35	52.18	118.18	55.62	121.62	133.18	104.00	107.03
35	890,000	10.00	13.00	44.20	86.80	154.00	52.93	120.13	53.78	120.98	137.06	106.92	107.67
36	900,000	10.00	13.00	45.50	88.25	156.75	53.68	122.18	51.80	120.30	141.08	109.96	108.27
37	910,000	10.00	13.00	47.00	89.70	159.70	54.43	124.43	52.55	122.55	145.32	113.26	111.52
38	920,000	10.00	13.00	48.20	91.15	162.35	55.18	126.38	53.30	124.50	149.36	116.27	114.54
39	930,000	10.00	13.00	49.40	92.60	165.00	55.93	128.33	54.05	126.45	153.45	119.35	117.60
40	940,000	10.00	13.00	50.50	94.05	167.55	56.68	130.18	54.80	128.30	157.49	122.37	120.60
41	950,000	10.00	13.00	51.50	95.50	170.00	57.43	131.93	55.55	130.05	161.50	125.33	123.55

At the same time that this measurement is made all large meters are read and the consumption of the smaller ones estimated so as to divide the total consumption into domestic and commercial demands. Following this measurement, subdivision or the breaking up of the distribution system into the smallest possible units, so as to secure a rate of flow on each portion thereof is made. This work is done at night to eliminate any large drafts by consumers. Following this all plumbing fixtures are inspected, and according to the rates of flow indicated by subdivision, investigations are made to locate underground leakage. Following the elimination of all waste possible a final measurement based upon the initial procedure is made. By comparing these two measurements all the pertinent information and comparisons can be obtained.

It is rather difficult to state exactly in terms of dollars what benefit the City derives from the surveys. Of course it is possible to make a summation of the various quantities of water saved and by applying a water service consumption rate of $0.70 per 1,000 cubic feet, give the equivalent saving. Although such statements are often made to justify the cost of the survey, this method is a fallacy. The water saved would have the value designated, if it could be sold; as it is however, the gain to the City is merely the sum equivalent to the cost of impounding, filtering, pumping and delivering this quantity. Upon this basis the water saved has cut down operating expenses $61.44 per day, or over $22,000.00 a year. A decrease in water consumption will, therefore, save money in the sense that it will ward off for additional years the necessity for enlarging the water works, and avoid the sinking fund payments, interest and operating expenses appurtenant to such enlargements.

In all an area covering 5.93 square miles having 152.74 miles of water mains, a population of 163,015 and a consumption at the time of the original recordings of 30,873,333 gallons has been measured. If sold at rates in accordance with the proposed Schedule of Water Rates for the City of Baltimore, this water would net a yearly return of $218,937.60. During the past year the cost of a survey has varied from $633.05 to $1,639.11. The cost of surveying a section has averaged, therefore, approximately $1000.-00, but by better coordination of the various factors entering into the work the cost is being slightly decreased, although the scientific work done has been enlarged upon.

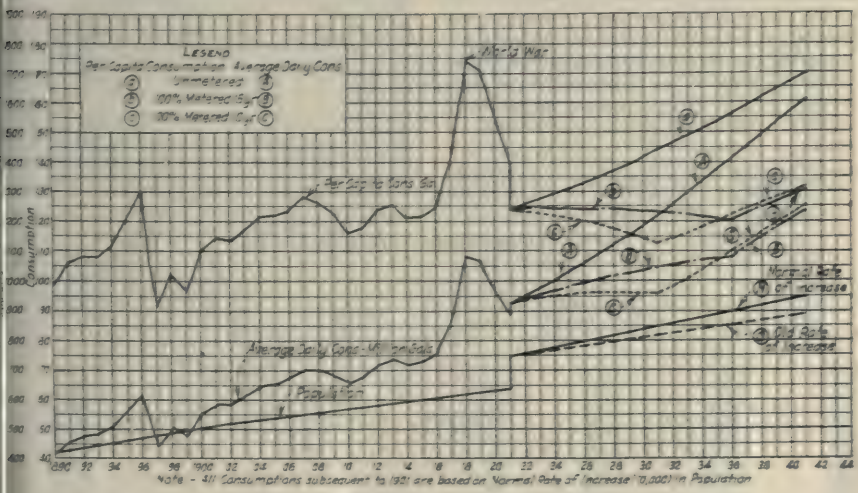

Fig. 1. Plate No. 4. Diagram of Population and Water Consumptions—Past and Prospective.

Benefits Apply to Sewer Dept. as Well as to Water Dept.—A pitometer survey may indeed be regarded as financially justified. To the Water Department itself, considering only a reduction in the expense of impounding, filtering and delivering a certain

quantity of water, the saving is large. To the taxpayers in general, there is a saving because the necessity for enlarging the water works plant is deferred for a number of years, and the interest and sinking fund charges on the investment required for such increases, are saved. Thirdly, the Sewer Division by a reduction of the pumping charges is benefited, for there is a direct relation between the amount of water consumed on each premises and the amount of sewage and waste water issuing therefrom. In the area now being measured, sewage flows by gravity to a pumping station where it is raised to a point sufficiently high to allow of a gravity flow through the out-fall sewer to the disposal plant. Any reduction in the water consumption in this area is therefore directly reflected by a corresponding reduction in the quantity of sewage pumped, a reduction in the water consumption being coincident with a reduction in the amount of sewage.

Increased Consumption in Baltimore.—Despite the saving effected by house inspection and by the pitometer survey, which is estimated to be in excess of ten million gallons per day, the average daily consumption of the City of Baltimore for 1922 was greater than that of the preceding year by more than three and one-half million gallons. For 1921 the average daily consumption was 88.94 million gallons while for 1922 this increased to 92.5 million gallons. The metered consumption for 1922 increased one million gallons over that of the preceding year, being 28.8 and 27.4 million gallons per day, respectively.

This increase in consumption is due to several causes, business conditions appear to be improving and many large plants are again running on a full or over time basis. Building in the suburban developments continues to be active and many extensions are being made to care for these enlarged communities. The acquisition and partial supplying of the several private water companies also contributes an extra demand upon the water sup-

Table V—Consumption of Metered Services

Year	Population (1)	% Metered 10 Yrs. (2)	% Metered 15 Yrs. (3)	Metered Per Capita Consumption—Gallons Commercial (4)	Domestic 10 Yrs. (5)	Domestic 15 Yrs. (6)	Total 10 Yrs. (7) 4+5	Total 15 Yrs. (8) 4+6	Average Daily Metered Consumption Mil. Gal. 10 Yrs. (9) 1x7	15 Yrs. (10) 1x8
1906	546,000	1.900		31.13					17.00	
1907	550,000	1.975		32.73					18.00	
1908	559,000	2.050		31.31					17.50	
1909	563,000	2.125		31.62					17.80	
1910	570,000	2.200		31.05					17.70	
1911	577,000	2.348		30.50					17.60	
1912	583,000	2.420		29.50					17.20	
1913	590,000	2.493		30.51					18.00	
1914	596,000	2.566		31.88					19.00	
1915	601,000	2.639		29.12					17.50	
1916	608,000	2.711		32.07					19.50	
1917	613,000	2.784		33.44					20.50	
1918	620,000	2.857		34.68					21.50	
1919	626,000	2.929		35.14					22.00	
1920	632,000	3.002		35.60					22.50	
1921	640,000	3.000		38.79					24.83	
1921	750,000	11.300		34.45	3.99		38.44		28.83	
1922	760,000	20.17	17.21	34.60	4.66	3.10	39.26	37.70	29.84	28.65
1923	778,000	29.04	23.12	34.00	9.39	6.25	44.39	41.25	34.18	31.76
1924	780,000	37.91	29.03	35.30	14.20	9.45	49.50	44.75	38.61	34.91
1925	790,000	46.78	34.94	35.70	19.07	12.71	54.77	49.41	43.27	38.24
1926	800,000	55.65	40.85	36.20	24.03	16.02	60.23	52.22	48.18	41.78
1927	810,000	64.52	46.76	36.80	29.06	19.37	65.86	56.17	53.35	45.50
1928	820,000	73.39	52.67	37.40	34.17	22.77	71.47	60.17	58.61	49.34
1929	830,000	82.26	58.58	38.20	39.34	26.23	77.54	64.43	64.36	53.48
1930	840,000	91.13	64.49	39.00	44.60	29.73	83.60	68.73	70.22	57.73
1931	850,000	100.00	70.40	39.90	49.93	33.28	89.83	73.18	76.36	62.20
1932	860,000	100.00	76.31	40.80	50.68	36.89	91.48	77.69	78.67	66.81
1933	870,000	100.00	82.22	41.80	51.43	40.54	92.23	82.34	81.11	71.64
1934	880,000	100.00	88.13	43.00	52.18	44.24	95.18	87.24	83.76	76.77
1935	890,000	100.00	94.04	44.20	52.93	48.00	97.13	92.20	86.45	82.06
1936	900,000	100.00	100.00	45.50	53.68	51.80	99.18	97.30	89.26	87.57
1937	910,000	100.00	100.00	47.00	54.43	52.55	101.43	99.55	92.30	90.59
1938	920,000	100.00	100.00	48.20	55.18	53.30	103.38	101.50	95.11	93.38
1939	930,000	100.00	100.00	49.40	55.93	54.05	105.33	103.45	97.96	96.20
1940	940,000	100.00	100.00	50.50	56.68	54.80	107.18	105.30	100.75	98.98
1941	950,000	100.00	100.00	51.50	57.43	55.55	108.93	107.05	103.48	101.70

ply. Highlandtown and the area formerly supplied by the Herring Run plant of the former Baltimore County Water & Electric Company, has been incorporated into the local distribution system since September, 1921, when the first portion of the section was added to our system This area is now entirely supplied by water from the Montebello Filtration Plant and consumes approximately four and one-half million gallons per day. This section is now a part of the Low Service zone of distribution.

The increased demands of Middle Service were caused chiefly by the extension of water mains in the Belair Road section. Highway Service remains practically unchanged except for the increase in consumption due to an enlarged population. The supplying of several small private water companies with water from this zone of distribution helped to increase the figure.

Considering only a normal increase in the population of the city and making no allowance for extensive increase in consumption due to resumed commercial, or rather industrial activities, the average daily consumption of the city will continue to increase year by year, even with a continuance of waste surveys.

Trend of Consumption.—The gross consumption of the city after decreasing over three billion gallons—from thirty-five billion in 1920 to thirty-two billion in 1921—increased in 1922 to almost thirty-four billion gallons, or an increase in the daily consumption of 3.56 million gallons. In 1919 careful estimates were made of the City's future development and various curves plotted showing the trends of consumption and the manner in which they would be affected by certain factors, such as an unmetered, partial, and one hundred per cent metered distribution system, with and without private water companies, and other modifying conditions. The average daily consumption for 1922 is already five million gallons greater than the estimated figures given on these trends of consumption, and with present conditions this excess will continue to grow greater and greater until curbed by metering.

But three per cent of the services in Baltimore were metered prior to January 1, 1922, being confined to industrial and commercial supplies. The acquisition of the private water companies, however, which are one hundred per cent metered has increased the percentage of metered services 8.3 per cent, so that on January 1, 1922,

TABLE VI—AVERAGE CONSUMPTION PER DAY—MILLION GALLONS

	Unmetered							Metered in 10 Years						
	High		Middle					High		Middle				
Year	East	West	East	West	South	Low	Total	East	West	East	West	South	Low	Total
1921	0.445	5.575	9.670	21.000	0.700	55.570	92.96	0.445	5.575	9.670	21.000	0.700	55.570	92.96
22	0.471	5.896	9.778	21.888	0.750	56.637	95.45	0.351	4.386	9.778	21.888	0.750	56.637	93.79
23	0.507	5.328	9.886	22.776	0.800	57.804	98.10	0.250	3.124	9.886	22.776	0.800	57.804	94.64
24	0.535	6.697	9.994	23.664	0.858	58.911	100.66	0.261	3.266	9.402	22.600	0.790	58.911	95.23
25	0.576	7.202	10.102	24.552	0.910	60.148	103.49	0.272	3.403	9.207	21.900	0.780	60.148	95.71
26	0.617	7.718	10.210	25.440	0.970	61.405	106.36	0.284	3.552	9.069	21.000	0.770	61.405	96.08
27	0.661	8.271	10.318	26.328	1.040	62.692	109.31	0.296	3.702	8.850	20.000	0.760	62.692	96.30
28	0.711	8.898	10.426	27.216	1.100	64.029	112.38	0.308	3.856	8.911	20.136	0.765	62.424	96.40
29	0.768	9.668	10.534	28.104	1.160	65.446	115.62	0.321	4.014	8.972	20.273	0.770	62.060	96.41
30	0.825	10.327	10.642	28.992	1.230	66.883	118.90	0.334	4.177	9.034	20.411	0.775	61.489	96.22
31	0.888	11.112	10.750	29.880	1.300	68.380	122.31	0.347	4.343	9.096	20.550	0.780	60.794	95.91
32	0.953	11.928	10.858	30.768	1.366	69.907	125.78	0.356	4.458	9.337	21.094	0.801	62.404	98.45
33	1.023	12.798	10.966	31.656	1.440	71.484	129.37	0.366	4.579	9.590	21.666	0.823	64.096	101.12
34	1.053	13.177	11.074	32.544	1.515	73.151	133.18	0.376	4.709	9.863	22.283	0.846	65.922	104.00
35	1.184	14.822	11.182	33.432	1.582	74.858	137.06	0.387	4.841	10.140	22.909	0.870	67.773	106.92
36	1.271	15.909	11.290	34.320	1.655	76.635	141.08	0.398	4.979	10.428	23.560	0.895	69.700	109.96
37	1.368	17.119	11.398	35.208	1.725	78.502	145.32	0.410	5.128	10.741	24.267	0.922	71.792	113.26
38	1.456	18.223	11.506	36.096	1.800	80.279	149.36	0.421	5.264	11.026	24.912	0.946	73.700	116.27
39	1.547	19.359	11.614	36.984	1.860	82.086	153.45	0.432	5.403	11.318	25.572	0.971	75.652	119.35
40	1.636	20.467	11.722	37.872	1.930	83.863	157.49	0.443	5.540	11.604	26.219	0.996	77.566	122.37
41	1.721	21.539	11.830	38.760	2.000	85.610	161.50	0.454	5.674	11.885	26.853	1.020	79.442	125.33
42	1.758	21.996	11.938	39.648	2.060	87.600	165.00	0.464	5.795	12.138	27.425	1.042	81.134	128.00
43	1.805	22.593	12.046	40.536	2.130	89.700	169.00	0.474	5.922	12.404	28.025	1.065	83.000	130.80
44	1.853	23.263	12.154	41.424	2.180	91.700	171.51	0.484	6.044	12.600	28.604	1.087	84.620	133.50
45	1.915	23.961	12.262	42.312	2.240	93.800	176.49	0.493	6.157	12.897	29.140	1.107	86.205	136.00
46	1.941	24.289	12.370	43.200	2.300	95.700	179.79	0.503	6.279	13.153	29.719	1.129	87.916	138.70
47	1.989	24.900	12.478	44.088	2.355	97.800	183.61	0.513	6.406	13.419	30.319	1.152	89.691	141.50
48	2.036	25.483	12.586	44.976	2.410	100.000	187.49	0.522	6.519	13.656	30.855	1.172	91.276	144.00
49	2.071	25.911	12.694	45.864	2.460	102.000	191.00	0.531	6.628	13.884	31.369	1.192	92.797	146.40
50	2.119	26.517	12.802	46.752	2.510	104.000	194.70	0.541	6.759	14.159	31.990	1.216	94.635	149.30
51	2.153	26.942	12.910	47.640	2.555	106.000	198.20	0.549	6.863	14.377	32.483	1.235	96.093	151.60
52	2.224	27.830	13.018	48.528	2.600	107.800	202.00	0.558	6.972	14.605	32.997	1.255	97.614	154.00
53	2.229	27.894	13.126	49.416	2.635	109.800	204.83	0.567	7.085	14.842	33.533	1.275	99.199	156.50
54	2.234	27.958	13.234	50.304	2.670	111.600	208.00	0.577	7.207	15.098	34.112	1.297	100.910	159.20
55	2.314	28.952	13.342	51.192	2.700	113.500	212.00	0.586	7.325	15.345	34.669	1.318	102.558	161.80
56	2.364	29.576	13.450	52.080	2.730	115.300	215.50	0.594	7.425	15.554	35.140	1.336	103.953	164.00
57	2.407	30.114	13.558	52.968	2.753	117.200	219.00	0.603	7.538	15.791	35.676	1.356	105.538	166.50
58	2.447	30.623	13.666	53.856	2.775	119.000	222.07	0.612	7.651	16.028	36.212	1.376	107.123	169.00
59	2.493	31.199	13.774	54.744	2.790	121.000	226.00	0.621	7.764	16.265	36.748	1.396	108.708	171.50
60	2.538	31.762	13.882	55.632	2.800	123.000	229.61	0.629	7.868	16.483	37.241	1.415	110.166	173.80

11.3 per cent of the total number of services in Greater Baltimore were metered.

Classification of Water Used Per Capita.—At present the average daily per capita consumption is approximately 125 gallons, divided as follows:

Commercial and industrial	34.6 gals.
Public and Municipal	10.0 gals.
Waste	13.0 gals.
Domestic	67.4 gals.

This represents an average daily consumption of 95,400,000 gallons. The population is 760,000 with a normal increase for the Old City of 7,000 inhabitants per year.

Due to war conditions in 1918, the population of Baltimore reached a maximum of approximately 790,000. With an average daily domestic per capita consumption of 79.2 gallons (based on actual number of residents, see Plate No. 4), the average daily domestic consumption is 62,596,000 gallons, commercial consumption, 27,334,000 gallons, and waste 18,170,000 gallons, giving a total of 108,100,000 gallons, or 20,000,000 gallons per day above normal.

Such conditions will be eliminated by metering, for the average daily consumption with a one hundred per cent metered system would have been but 86,000,000 gallons or a saving of 22,100,000 gallons per day. In 1921 after conditions had become somewhat normal the average daily per capita consumption dropped to 138.97 gallons (January 1, 1922). The consolidation of the metered private water companies with the City distribution system decreased the daily per capita consumption of Greater Baltimore to 124 gallons.

Programs for Metering and Anticipated Results.—Consideration will now be given to metering the City in ten and fifteen years (using as a base, 1921 upon which year the recommended schedule of rates is based).

Plate No. 4, the present and future consumption and the reduction through the installation of meters over a period of ten and of fifteen years, shows that it is not necessary to meter the water supply services within a period of three years. The Water Department can well handle without any material enlargement of its organization the installation of 9,200 meters per year for a fifteen-year period or 13,800 meters per year for a ten-year period. In a number of municipalities contracts for the installation of meters were awarded with consequent dissatisfaction to the

Table VII—Comparison of Water Consumption In Philadelphia, Detroit and Baltimore

		Philadelphia 1920	Detroit 1920	Baltimore 1922	
(1)	Population	1,828,158	993,739	750,000	
(2)	Total service connections	388,000	164,779	155,000	
(3)	Number persons per service connection	5	6	4.84	
(4)	Number connections, 2-in. and others, supplying industrial and commercial users	1,854	1,219	1,217	(a)
(5)	Number persons per connection of (4)	983	816	616.2	(b)
(6)	Number miles of water mains	1,911	1,483	993	
(7)	Percentage of all services metered	23	98-100	11.3%	
(8)	Gallons per capita daily consumption all purposes within city	173	131.34	123.9	
(9)	Gallons per capita daily consumption, industrial and commercial users meters, 2-in. and over	41.1	42.77	18.54	(c)
(10)	Gallons per capita daily consumption, municipal uses	13.7*	17.44	10	*
(11)	Gallons per capita daily consumption all other purposes, domestic, leaks in service connections and mains, flushing mains, etc. (8) minus (9) and (10)	118.2*	71.13	95.35	
(12)	Domestic metered and flat rate accounts	.....	50.71	76.53	
(13)	Miscellaneous accounts, stores and commercial not under (11)	.....	6.63	5.67	(d)
(14)	Service connection leaks	.....	5.45	0.04	(e)
(15)	Leaks in mains and flushing mains	.....	3.98	0.11	(e)
(16)	Unaccounted for	.....	4.36	13.00	(f)
(17)	Total (12) + (13) + (14) + (15) + (16)	118.2	71.13	95.35	

*Estimated.
(a)—And 744 additional unmetered private fire protection supplies.
(b)—If fire supplies included, 382.4.
(c)—Based on 365 days in year.
(d)—Commercial meters less than 2-in. included in (11) but not in (9). Based on 365 days in year.
(e)—Estimated from Pitometer Records.
(f)—Not 100% metered system.

operators and it would be unwise to o inaugurate such a program. It is better practice for the Water Department to do this work than to let it out by contract, as standard material will be used and better workmanship will be possible with constant adherence to recognized practices.

The most economical method will be o first meter the High Service area, as this section has the largest per unit operating expense, Middle Service next, and then Low Service, the time required being two years for High, four years for Middle, and four years for the Low Zone of Distribution, considering a ten-year period, and three, six and six years, respectively, with a fifteen-year period.

In these determinations the following assumptions were made:

The average daily unmetered per capita consumption—based on past conditions—will increase 1.45 gallons per year.

When totally metered the average daily per capita domestic consumption —based on past conditions—will increase 1.45 gallons per year.

When totally metered the average daily per capita domestic consumption will increase 0.75 gallons per year.

The average daily per capita consumption will decrease to 50 gallons with one hundred per cent metering.

Metering will be uniform.

The population due to probable industrial and commercial growth will increase at a rate of 10,000 a year (7,000 in Old City).

The commercial consumption will increase as shown in Table No. 4.

Public and waste per capita consumption will remain constant at ten gallons and thirteen gallons, respectively.

From this the values of consumption were calculated for the years following 1921 and the curves of Plate No. 4 plotted.

The following interesting and important information is derived from the preceding values. There is but a slight difference in the saving in consumption between metering in ten and metering in fifteen years. The saving of a metered over an unmetered system is, however, quite large, amounting to over thirteen and a half billion gallons for the year 1941, equivalent to twenty-three per cent of the unmetered consumption. The saving in consumption and operating expenses, etc., for various years is shown in Table No. 17 (to be published in a later issue). The public and waste consumption in 1941 will amount to 21,000,000 gallons per day. The average daily metered domestic consumption will be 53,000,000 gallons per day. The average daily metered domestic consumption will be 53,670,000 gallons per day, equivalent to 43.28 per cent of the total consumption, or by metering the average daily domestic consumption will be reduced forty-one per cent.

Due to the difference in consumption between unmetered and metered systems, the draft on Loch Raven will be considerably reduced. As the available supply is 146,000,000 gallons per day, the dam must be raised or some new source of supply selected when the consumption of the city reaches or exceeds this amount. With an unmetered system this improvement must be made in 1937 and with a metered system in 1947—a postponement of ten years. All other improvements will likewise be deferred from ten to fourteen years.

An article entitled "Universal Metering Recommended for Philadelphia," in the Water Works News of June, 1922, makes a comparison between the reduction in consumption

Table VIII—Per Capita Consumption on Various Sizes of Meters—1921

Size of Meter in.	Number of Meters in Service	Consumption Gallons	Percentage of Metered Consumption	Population Supplied Through Meters Gallons	Per Capita Per Day Gallons
⅝	1,127	313,298,500	3.8	8,691	95
¾	1,335	529,297,000	6.4	20,188	71
1	669	674,204,500	8.2	19,763	93
1½	352	613,882,000	7.5	18,423	91
2	490	1,144,619,500	14.0	26,056	120
3	373	1,830,104,500	22.2	28,291	177
4	162	1,972,032,000	23.9	27,107	199
6	57	1,161,554,500	14.0	16,499	199
Total	4,565	8,238,992,500	100.0	165,018	136

by the installation of meters in Cleveland and in Detroit:

"From 1890 to 1901 the daily per capita consumption in Cleveland increased with some variations in tendency from 101 to 172 gallons. At that time only a few meters were in use, but then rapid installation was commenced and by 1909 the city was practically entirely metered. During the period of eight years the per capita consumption decreased quite uniformly from 172 to 94 gallons daily, representing a reduction of 78 gallons. From 1909 to 1917 the consumption increased quite uniformly to 116 gallons per capita. In 1918 it was 137.5 gallons due largely to increased industrial demand from plants operating day and night to fill war orders. The 1919 and 1920 consumptions, however, were about 130 gallons, and the engineers attached to the city's water organization estimate that the per capita demand in 1924 may be increased to 150 gallons daily. It is a singular fact that the industries in Cleveland now use sixty per cent of the total consumption, or about 78 gallons per capita, while the metered usage in Philadelphia and Detroit on connections 2-inch in size and larger only slightly exceed 40 gallons. The experience of Cleveland with complete metering of service connections indicates that the predicted reduction of per capita consumption daily of at least 40 gallons in Philadelphia through similar measures is not unreasonable."

Table No. 8 states the per capita consumption per day on various sizes meters based upon actual meter readings taken within the 1888 boundary line of the city during 1921. The smaller sizes of meters are installed principally in apartment houses and stores, the larger sizes serving industrial and manufacturing plants, hotels and other large consumers. The average number of fixtures in the above mentioned places is greater than in the usual one-family house and the water is used for many purposes and in all except apartment houses and hotels the consumption continues throughout the usual working day. There is no question in my mind that the total per capita consumption for one-family houses will be less than half of that shown in Table No. 8.

(Part II to be published in Engineering & Contracting for Sept. 12.)

Dams Constructed by U. S. Reclamation Service

In connection with its irrigation project the U. S. Reclamation Service has built three dams, each over 300 ft. high, two dams between 200 and 30 ft. high, four dams between 100 and 200 ft. high, and nearly 100 dams ranging from 2½ ft. to nearly 100 ft. high. The three highest dams are: Arrowrock in Idaho, 349 ft.; Shoshone in Wyoming, 328 ft., and Elephant Butte in New Mexico, 306 ft. At the present time the Service has six dams under construction, their estimated volume and height being as follows:

Name	State	Volume Cu. Yd.	Hght. Ft.
Tieton*	Washington	1,850,000	244
McKay	Oregon	2,300,000	159
Black Canyon	Idaho	74,500	153
Hubbard	Montana	16,000	104
Willwood	Wyoming	18,500	68
Wind River	Wyoming	17,000	27

*Maximum height to bottom of corewall is 321 ft.

"Spear" Method of Increasing Flow of Wells

In order to keep the draw down to about 8 ft. in the wells of the Inkerman Irrigation Scheme, North Queensland, lateral "spears" are driven into the surrounding drift from inside the well. These spears have the effect of tapping the large area of water surrounding the well, and permitting it to flow directly into the well, instead of percolating through the drift, which of course would retard its flow. These spears are simply galvanized iron piping from 1½ in. to 2 in. diameter, perforated with a good many ¼ in. diameter holes, and vary in length from 4 or 5 to 16 or 18 ft., the average being about 8 or 9 ft.

Large Mixers on Hydroelectric Development.—The T. L. Smith Co., of Milwaukee, has just shipped to Hebertsville, Canada, two 4-yard (112-S) Smith tilting mixers for use on the hydraulic dam project at Hebertsville. These mixers are duplicates of the two that were used at the Muscle Shoals. Four more 56-S (2-yd.) mixers of this same type are now being built for use on the Wilson Dam project across the Tennessee River, at the foot of Muscle Shoals, on which two of the Smith 4-yd. and two 2-yd. tilting mixers were formerly used. The Wilson Dam will require 1,260,000 cu. yd. of concrete.

Preparation of Water for Filtration

Problems and Modern Methods of Handling Described in Paper Presented Before Canadian Section of American Water Works Association

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It is the purpose of the authors of this paper to confine their remarks to a consideration of the existing water supplies for the municipalities of Ontario.

The sources of supply for municipal waterworks in Ontario are rather unique in that with very few exceptions they are known as "clear" waters. The Great Lakes and the connecting rivers, which form the major sources of supply are extremely clear, and such turbidity as occurs is of local origin, and as a rule is confined to a small percentage of the 365 days of the year. The Lower Detroit is an exception to this and carries more or less turbidity during the greater part of the year. The Upper Detroit has some unusual conditions during the spring run-off, brought about by the enormous quantities of salmon-fly larvae, which are introduced from the creeks and shore waters of Lake St. Clair. Lake Erie, which is comparatively shallow, is more or less rile after every storm, and would have considerably more turbidity than is encountered in any of the other Great Lakes.

In addition to the Great Lakes and connecting rivers there is a considerable number of comparatively clear streams and springs, the source of which have considerable iron in solution. In Northern Ontario, and associated with the waters of the Rideau and Trent Valleys, there is quite an amount of organic matter and definite colour. These waters again are comparatively clear, except as influenced by the spring run-off and the effect of the organic matter thrown into suspension by convexion currents, or due to stream velocity affecting the deposit of suspended matter.

Besides these, there are a few sources of supply, such as the Thames and the Grand Rivers, which carry considerable amounts of turbidity and which rank as hard waters.

Problems in Filtration.—The problems of filtration, dealing with such waters confine themselves in the main to three problems:

(1) The removal of bacteria, introduced from sewage contamination.

(2) The removal of occasional turbidity.

(3) The removal of colour and organic matter and, for a few of the supplies the removal of considerable quantities of turbidity.

Economically the problem in the main is a problem of the removal of colour in the Northern parts of the province; and for the Trent and Rideau valleys, the removal of iron and the removal of occasional turbidity.

The operation of filtration plants for the removal of over 95 per cent of the bacteria, introduced by sewage pollution, from the clear waters of the Great Lakes, has lately been a controversial subject. There appear to be two schools of thought. One is represented by the works managers and economists, who insist that, without impairing the appearance of the water great economy can be effected by reducing the bacterial efficiency of the filtration process and supplementing the treatment by sterilization through the use of chlorine, ozone, or ultra-violet ray. The other school is represented by certain public health officials, who take the position that in connection with our water supplies we cannot have too great a factor of safety, and that filtration should be formed in as efficient a manner as is possible with the highest bacteria removal consistent with the capacity of the plant; and that this should be further supplemented by chlorination.

In the larger plants, which can afford laboratory control, the former school undoubtedly have the advantage of the argument, since with our knowledge of the behavior of chlorine as a sterilizing agent, we can ascertain with great accuracy the efficacy of sterilization agencies, by the colormetric determination of excess chlorine in the water. The plant operator knows if a certain excess chlorine exists in the water that the water is sterile and there is no occasion to wait upon the laboratory 24 to 43

hours to obtain the bacterial counts and results of the fermentation tests.

The Trend of Practice.—The argument of economy is rather a difficult one to combat in these days of high taxes caused by our war indebtedness when it is realized that the quantities of alum required to give high bacterial efficiencies represent an annual expenditure considerably in excess of the annual amount of principal and interest charges on the capital cost of the plant itself.

One grain per gallon per plant capacity, applied daily, equals approximately the annual amount of the principal and interest of the plant, at 4½ per cent 30 year debentures.

Where the water is to be treated with approximately 2½ grains of alum, the cost of alum alone is from two to three times the actual costs of the interest and principal in connection with the plant itself. The trend of practice, therefore, is toward decreasing the bacterial efficiencies of filtration plants of the rapid mechanical type and supplementing filtration by chlorination. This trend, whether in the right direction or not, fortunately at this time is not accompanied with very serious health hazards, owing to the fact that the last ten years have witnessed immense declines in incidences of typhoid fever, so that water supplies do not today represent the potential danger that they did in the last decade.

In the province of Ontario a great deal of emphasis has been placed and is still placed upon the location of points of intake for sources of supply. There was a tradition some years ago that American engineers were prepared to purify any source of supply and make it fit for domestic use. And while the writers do not wish to reflect at all upon the ability of the American engineers to design such plants, and have in fact witnessed such achievements, they do take issue with the practice of utilizing sources of supply, with a view to ecohomy, which are far from satisfactory.

Selection of Point of Intake.—In Ontario, the selection of the point of intake as a rule is determined upon only after a very considerable survey of the sources of sewage pollution likely to affect the intake. In consequence, there are very few plants in the Province, furnishing domestic water supplies, which have intakes subject to the gross pollution that is experienced in a great many of the American cities.

As a result of this, lapses in the purification processes do not tend to contribute the complement of typhoid fever which one would anticipate from the American situations, and it is also possible to operate these plants with considerably less supervision than is required of those dealing with highly polluted waters. The density of population in the United States call for a size of plant which is rather larger than the general run of plants in Ontario. This also is a factor in the extent to which supervision and laboratory services can be absorbed in water rates.

In order that the trend of design might follow more closely the present practices in operation of filtration plants, dealing with the clear, uncolored waters, such as are furnished by the Great Lakes basin, the writers believe that the discussion of the precipitation re-action of aluminum sulphate is a pertinent matter.

Heretofore, in standard plant design, it has been customary to provide sedimentation and coagulation basins for from two to eight hours' sedimentation. These basins represent from 10 to 30 per cent of the total cost of the filter works. They were introduced originally to assist filtration by settling out a portion of the suspended matter, or turbidity. In many of the older works where treatment by chemicals and precipitation preceded treatment by filtration, the precipitation tanks were existent prior to the installation of the sand filtration works, and were merely made an adjunct to the new works.

The filter units themselves were of both the open gravity and the enclosed pressure type. It was also believed by many of the workers that economy could be effected in the quantities of alum used, if advantage were taken of the reacting interval of several hours, which fact, we believe, has been amply borne out in practice.

Colored and Iron Waters.—In Ontario, in dealing with the colored waters in the North, and in dealing with the iron-bearing waters, coagulation and retention tanks prior to filtration appear to offer distinct advantages, not only through economy

in the use of alum, but, also, in providing a certain flexibility in plant management, permitting aeration and other adjuncts such as carbondioxide removal, sometimes found necessary in the treatment of these types of waters.

There are numerous instances in Ontario where pressure filters can be operated so as to yield a satisfactory water, but the difficulty of controlling the requisite alum dosage required for rapid precipitation is so great that this type of plant is not advocated for waters which may be classed as resistant to treatment.

On the other hand, there may be a field for this type of filter when dealing with the comparatively clear water of the Great Lakes basin since they are capable of preparing it for effective chlorination and are also available for the removal of occasional turbidity, provided a suitable laboratory force is available to regulate the administration of chlorine and the requisite dosage of alum and chemicals necessary when dealing with periodic turbidities.

The question which naturally arises as to whether the saving of 15 to 20 per cent of the capital cost of the plant is warranted, when it throws the burden back upon the laboratory, is a debatable one. Fifteen per cent of the capital cost represents in annual operation approximately one-tenth the total cost of the water as delivered from the pumping station to the distribution system, so that the item is not possibly as large as one might anticipate.

Optimum Condition of Raw Water.—During the past year the Board has been carrying on special investigations in different parts of the Province with a view to determining if possible the optimum condition of the raw waters associated with coagulation, using aluminum sulphate. The experimental evidence in our possession would indicate that for the soft, colored waters the optimum is when the natural water has a hydrogen ion concentration capable of adjustment through the use of alum to a pH value 5.5 and that for the harder waters and the Great Lakes basin the optimum condition is when the pH value is adjusted to the neighborhood of 6.5.

The recent report of Theriault and Clarke appearing in Public Health Reports for February 2, 1923, under the caption "The Experimental Study of Hydrogen Ion Concentrations to the Formation of Floc in Alum Solutions" is a notable contribution to the subject. They were able to show that the time of the first appearance of the floc in mixtures of alum and water containing definite salt concentrations behaves according to an equation, which is graphically represented by a parabolic curve; the axis of the parabola is oriented at right angles to the abscissa the optimum pH value. In solutions having a high alum concentration, the parabola appears to have a wider curve than where the dilute solutions are used, the practical application of this phenomena being that the hydrogen ion concentration range in which precipitation occurs is very much more limited for dilute solutions than for solutions of a higher concentration, and it is also apparent from reference to the curve that as one progresses from the optimum pH the time for the first appearance of the floc increases up to a point where the curve becomes practically perpendicular to the abscissa, so that beyond the confined range, in which precipitation is observed to occur there appears to be no hope of precipitation, even if the time of interval be prolonged indefinitely.

The use of salts other than alum for the adjustment of the hydrogen ion concentration has not as yet met with a great deal of success. The two salts most commonly used for this purpose, sodium carbonate and lime, both have an unfortunate effect on the formation of floc. Under certain conditions the aluminum hydrate apparently acts as an acid, re-acting with calcium hydrate to form a calcium aluminate and it would, also, appear to react with sodium carbonate and bicarbonate to form a sodium aluminate or some other compound. These reactions, which are reversible, have not yet been carefully worked out, but it is safe to assume that there will be a loss of alum floc in the presence of free hydroxide and generally in the presence of sodium salts of the rather weak carbonic acid.

Mechanical agitation of sand such as in the ver Mehr filter, does not, in the writer's opinion, accelerate precipitation appreciably. Theoretically, it may, but the probability is that the presence of a large volume of sand in the filter has considerably

more to do with precipitation than the movement of the sand, so that in actual practice there is very little to choose between the precipitation efficiency of the ver Mehr filter, does not, in the writer's opinion, accelerate from the point of view, solely of chemical application, the theoretical advantage of the ver Mehr filter more or less disappears.

Present Practice in Filter Operation.—In summarizing the conclusions of the writers it would appear that the present trend of practice to operate filters, more or less as a screen for the protection of chlorination processes on our clear lake waters, is a sound one, in respect to larger installations, provided the laboratory facilities are adequate to keep a very definite check on the residual chlorine, and provided the situation is such that the secondary application of chlorine is possible, in order to correct any mischance in the dosage.

The use of sedimentation, or coagulation units having a minimum of two hours' storage is extremely advantageous for all colored waters and iron-bearing waters. For iron-bearing waters provision should be made for the addition of supplementary chemicals other than alum.

In this connection the experiments of Alfred Bechtel at Allentown indicate that it takes 30 minutes after the addition of calcium hydroxide, either as the powder or as milk of lime, before the calcium hydroxide is in true solution so that where lime is used to remove carbon dioxide the treatment must take place at least 30 minutes before the use of alum.

The pressure type of filter without coagulation basins is adequate, provided theoretical quantities of alum are applied to take care of occasional turbidity. If this turbidity is of frequent appearance, or persists for any considerable interval of the year, such as a month or several months, it is our opinion that the addition of coagulation tanks and sedimentation is economically sound, and lends itself to plant management.

For the removal of excess carbon dioxide following the use of alum, it is recommended that the water be treated after filtration with the requisite quantities of sodium carbonate or lime.

The Clogging of Intake Screens by Fish

From a Paper Presented at the Convention of the American Water Works Association, May, 1923

By LEONARD METCALF
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In designing a new 54-in. intake and supply conduit for the Portland, Me., Water District, to bring water from Sebago Lake into and thus increase the capacity of the supply pipe system, the writer chances to encounter the fish problem in an interesting way. During the spawning season considerable difficulty had been experienced at certain times in the screen chamber, and as engineering literature upon the subject was meagre, the actual experience in the past with the old intake pipe was investigated as the best evidence upon which to predicate the new design. These data are now presented to this Association in the hope that they may call forth the experience of others with fish in their screen houses, and the methods used for mitigating or removing the difficulties.

Old Intake and Supply Conduit.—The old intake consisting of about 480 ft. of 48-in. cast iron pipe, was laid in 1898 from the gate house to the inlet, which is 450 ft. from the shore line of the lake. The pipe was laid in trench, under cover, for a distance of about 264 ft. from the shore, at which point the depth of water over it is from 7 to 8 ft., under average water conditions, and 3½ ft. at legal low water limit.

The end of the intake consists of a 48 in. x 48 in. x 48 in. tee pointing up, laid on the bottom of the lake, with the top of the bell of the intake 14 ft. under water at mean lake level, and 10.5 ft. at the legal limit for low water. The bottom is covered with large boulders and there is little, if any, growth on the floor of the lake at this point. The 48-in. intake enters the gate house into a chamber 7 ft. long by 8 ft. wide, unfortunately at a slight angle (about 25 degrees) with the axis of the chamber.

At a distance of 7 ft. from the point of entry the water passes through the screens. These screens are in duplicate, with little cages at the bottom to catch the refuse as the

creens are raised to clean them. In ie cleaning one set of screens and ien the other is raised, cleaned and eplaced, so that ordinarily the water asses through two sets of screens. ach of the screens consists of a eries of units placed one on top of nother, sufficient in number to cover ie water section from the under side f the inlet pipe, to high water in the ike, a distance of something over 10 .

The screening units have wooden ames of 1 in. x 3 in. lumber bolted ogether with copper wire mesh se- ured between them. The screen area cut in two by a midrib of 1 in. x 3 n. stock. Each screen unit, 7 ft. 3 in. 27 in., has a gross wire mesh area f 11.375 sq. ft., or a net water area f 7.45 sq. ft., equivalent to 65.52 per ent of the gross wire area. The iesh is of copper wire 0.065 in. in iameter, 0.355 in. on centers longi- udinally and 0.328 in. transversely.

As stated, the water from the lake iters the screen house unfortunately a slight angle from the normal to ie screen, which prevents uniform ctilinear flow to the screen and ual distribution of velocity in the reads of the stream and causes the ain current to impinge against the all diagonally opposite the opening, id to flow thence towards the fur- ier end of the screen instead of wards its midsection.

Experience With Fish.—The writer sited the screen house, with Mr. arry U. Fuller, Chief Engineer of ie Water District and the Resident oreman, Mr. Marshall Higgins, at 8 clock on the evening of Jan. 22, 23. The evening was clear and ld. The lake was covered with ice, ith a 2 ft. mantle of snow upon it.

There were relatively few fish in e gate house above the screens— rhaps two quarts in volume and veral hundred in number. The fish ried in length from 3 to 4½ in., the ickness of the body being from 1¼ 1½ in. When the screens were moved about one quart of fish were ken from the baskets upon them. iere were removed in the course of ie 24-hour period 2½ quarts of fish. ie fish were of a smaller type than ose which run up to the lake to awn. The latter are usually from to 12 in. in length. The fish taken ere were apparently mature, however, because well-developed spawn, in a condition about ready to be cast, was found in a number of fish, varying from 3½ to 4½ in. in length. The fish appeared to swim readily against the current, and were not drawn up against the screens to any great extent. Yet the dead fish in the baskets indicated that they had been drawn against the screens and drowned before they were able to get away from them. The irregular flow of the water in the screen house, with the boiling tendency referred to, was indicated by the way in which the fish rolled up from time to time with the current from the greater to the lesser depths, showing their flashing bellies, apparently unable to maintain their vertical position.

Mr. Higgins stated that trouble was experienced with the fish generally during a three months' period from Dec. 15 to March 15, though the run of fish had sometimes begun as early as the latter part of November and continued for a longer or shorter period than that referred to above. He was of the belief that the worst conditions were found immediately before bad storms even with ice and snow on top of the water.

The worst experience, he said, was had in the winters of 1904-5 and 1910-11, when one or two bushels of fish were taken out in a 24-hour period, instead of a few quarts. During one of these periods the clogging of the screens by the fish was so serious that on one occasion the screens were actually burst and the fish which came through gave serious subsequent trouble in the pipes. During more or less of the three months' period referred to, it has been the custom to visit the screens at frequent intervals during the day and more recently, as during the past year and this winter, to have a man in the screen house throughout the night, netting the fish and removing them from the screens as a precautionary measure to prevent serious clogging. Mr. Higgins was of the opinion that there had been one or two nights in which, had there not been a man present, there might have been serious trouble from the clogging of the screens.

The recent trouble was probably due to two facts,—first, the increased rate of water consumption of the present, as compared with the past;

and second the present low water level of the lake.

Water Conditions and Fish Troubles.—The record of water levels in Sebago Lake was subsequently examined carefully, particularly with reference to the minimum levels during the months stated (Dec. 15 to March 15) in the period of years from 1904 to date; and the mean daily consumption was determined so nearly as possible. These data were then studied with reference to the conduit capacity, the actual net water area of the screens at different levels, and the maximum hourly water consumption, based upon an assumed maximum 50 per cent in excess of the mean daily consumption during the year. The result is interesting. It indicates the reason for the conditions reported by Mr. Higgins as having been observed in the years 1904-1905 and 1910-11.

In the first instance the trouble was clearly due to low water level in the lake (El. 261.5), though in this connection it is to be borne in mind that the present minimum legal low water level is above this (El. 262.5) and that the water is not likely again to reach the observed low level.

The trouble on the second occasion, 1910-11, was due to the combined effect of low water (El. 262.3) and the relatively higher rate of consumption in that year (8.7 Mgd. as compared with 7.2 Mgd.)

The trouble during the last two years has been due to the increased consumption, which has averaged 13 Mgd. with a maximum of 20 Mgd., rather than to the lake level, the lowest level of which was El. 264.4 in 1921-22, and El. 264.8 in 1922-23.

The developed facts indicate that when the mean velocity of flow through the water area of the screen, based upon the mean daily water consumption of the year, reaches an amount of 0.8 of a foot per second, or exceeds it, and when the maximum rate of flow through the water area of the screens, based upon an assumed maximum rate of 50 per cent in excess of the mean daily rate during the year, is equal to 1.2 ft. per second, or more, serious trouble has been experienced from time to time with these fish under the conditions described as prevailing in this screen house.

It may well be, however, that if the 48-in. cast-iron pipe, at its entrance into the gate house, had been so located as to discharge at right angles to the face of the screens, the trouble would not have been experienced, certainly at such low mean velocities as those stated, because the velocity of approach to the screen would have been much more uniform than it is in fact under existing conditions.

Minimum Velocity Desirable.—It would be prudent, if practicable, in designing the screens for the screen house upon the new conduit, to keep the velocity of flow through the water area of the screen down to 0.5 ft. per second, based upon the mean daily consumption during the year. In this connection it is to be borne in mind that the water section of the ordinary woven wire screen is approximately two-thirds of its gross area, and of the punched metal screens not over one-half, and in some punched metal as little as one-fourth.

Conclusions Relative to Influence of Fish.—It appears reasonable to conclude,—

First, that it is desirable to keep the velocity of flow through the water section of the screens down to 0.5 ft. per second, on the basis of the mean daily flow during the year;

Second, that this limit may be substantially exceeded if the velocity of approach is uniform and normal to the screen face;

Third, that if the approach to the screens be rectilinear and the velocity fairly uniformly distributed in the section and if the flow be parallel to the face of the screens as the water passes through the screen chamber up to the point of passage through the screens, thus tending to make it much easier for the fish to keep clear of the screen surface, higher velocities can probably be used with safety.

Civil Service Examinations.—The U. S. Civil Service Commission, Washington, D. C., has announced the following open competitive examinations: Hydrographer, U. S. Reclamation Service, at entrance salaries ranging from $1,680 to $1,920 plus $20 per month; hydrographic and topographic draftsman, U. S. Coast and Geodetic Survey, at entrance salary of $1,400 plus $20 per month.

A $4,500,000 Texas Water Supply Project

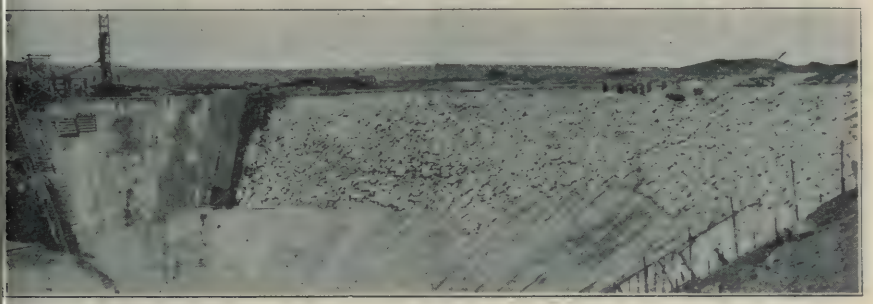
Dams and Canal System Now Under Construction for Wichita County Water Improvement District No. 1

By R. A. THOMPSON
Chief Engineer, Wichita County Water Improvement District No. 1

On Dec. 20, 1919, the Wichita County Water Improvement District No. 1 of Wichita Falls, Tex., a municipal corporation, was organized to construct a storage dam on the Wichita River, about 42 miles out of Wichita Falls, a diversion dam some 13 miles below, and a canal system. The purpose of the project was primarily to provide a permanent water supply for the city of Wichita Falls, but sufficient water will be impounded to irrigate some 100,000 acres of fertile land in the valley below.

On Sept. 7, 1920, $4,500,000 bonds were voted to build the works. Construction began Feb. 25, 1922. Both the storage dam and diversion dam will be completed in October. The main canals and distribution system to irrigate 50,000 acres will be completed by the summer of 1924.

Storage Dam.—The storage dam is a hydraulic fill structure, 100 ft. maximum height and 7,500 ft. long. It contains 1,500,000 cu. yd., of which 200,000 cu. yd. was built with teams, the remainder being placed with an electrically operated hydraulic dredge having a 20 in. discharge line. A 38,000 volt power line 41 miles long was built to operate this dredge. The pump is direct connected with a 1600 h. p. AC motor, 2200 volts, 60 cycle,



Service Spillway at Storage Dam of Wichita County Water Improvement District No. 1.

Placing Hydraulic Fill in Storage Dam, Trap Pipe Being Used to Reduce Volume at End of Pipe.

speed 360 r.p.m. The capacity of the dredge is from 200,000 to 250,000 cu. yd. per month under normal conditions.

The material for the embankment was taken from the valley upstream, and is composed of gravel, sand and clay of most excellent proportions for making a fill of this kind.

The upstream slope of the storage dam is 3:1 to spillway level, and 2:1 above spillway. The downstream slope varies from 2:1 at top to 3:1 at bottom. The upstream slope is riprapped with 18 in. hand placed rubble rock on 8 in. of gravel blanket. The dam is 25 ft. wide on top and will be graveled for a roadway.

At the south end of the dam are six circular outlet conduits, each 7 ft. in diameter and 430 ft. long. Four conduits are for temporary use, to pass floods during the construction period, and will be closed. The two permanent conduits are fitted each with two cast iron gates with bronze facings, and are operated by motor with power generated by a small gasoline unit. The conduits contain about 6,700 cu. yd. of concrete.

Core Pool of Storage Dam.

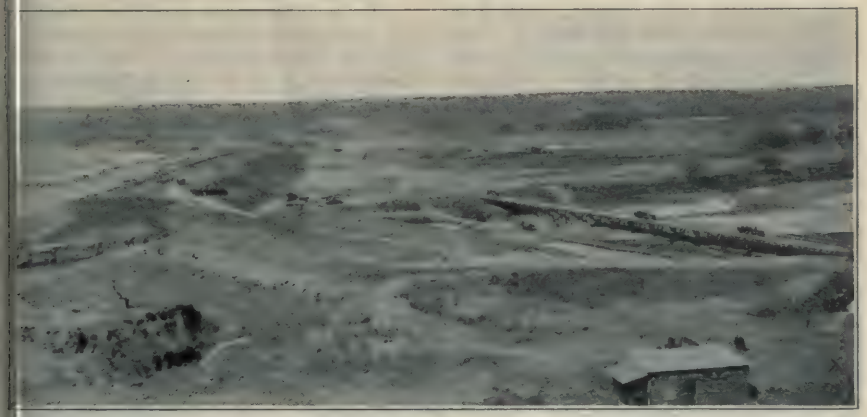
Upstream Slope of Storage Dam.

The service spillway is located at the head of a natural depression near the north end of the dam. It is of semi-conical form with 180 ft. radius at top and 45 ft. at bottom, and 90 ft. deep. The slope is 1½:1 and is paved with heavy rubble rock, well grouted. The surface is finished smooth. The bottom of the spillway is paved with 30 in. grouted rubble and 6 in. of con-

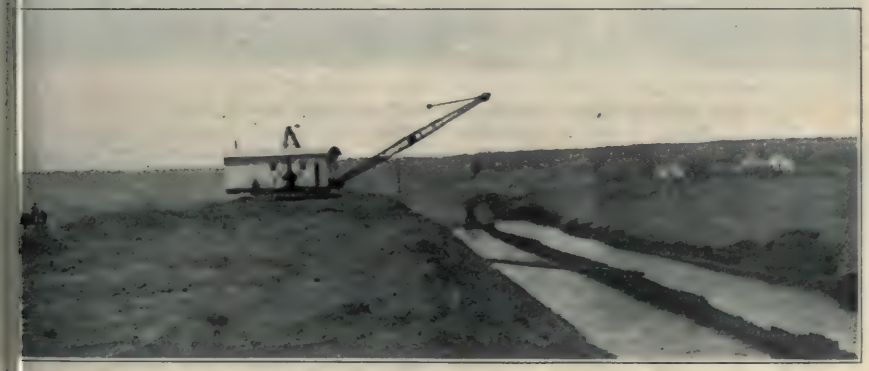
ete on top, and is 5 ft. below river 'd at crossing. A 24 in. curtain wall carried down 10 ft. deeper.

A hollow type reinforced concrete m about 12 ft. high and 565 ft. long sts on the cap rock at the top of the ope. The slab is 8 in. thick and is pported by buttresses spaced 8 ft. An emergency spillway is built at e extreme north end of the dam, nsisting of two low sections of em- nkment between concrete headwalls, e 70 ft. long and 8 ft. higher than e crest of the service spillway, and e other 335 ft. long and 10.5 ft. igher. The combined capacity of all pillways is 200,000 second feet when 0.5 ft. deep on service spillway crest, r 4.5 ft. below top of dam. The spill- ays contain about 7,500 cu. yd. of oncrete masonry.

A cut-off wall of steel sheet piling (35 lb. per square feet) was driven for 1,320 ft. across the valley into clay and shale foundation from 6 to 8 ft. A trench was first excavated to river level 20 ft. wide at bottom, with side slopes of 1:1, in the center of which the piling was placed. The piling stands 6 to 10 ft. high in the trench, and is encased in the puddled fill.



Spillway Site and Headgates at Diversion Dam.



Backfilling Muck Ditch at Diversion Dam.

Under the remainder of the dam a core trench was excavated from 5 to 10 ft. into the shale and carefully puddled and tied with the central core of the dam.

The total cost of the storage dam will be about $1,400,000.

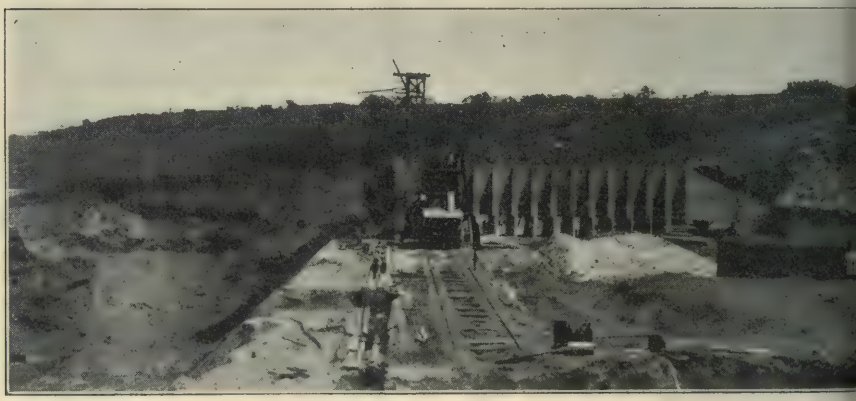
Diversion Dam.—The diversion dam is built across the river valley about 13 miles below the storage dam, and is for the purpose of diverting the

water into the canal system. This dam is 4,100 ft. long, 54 ft. maximum height and 16 ft. wide on top. Its upstream slope is 3:1 to spillway level 19 ft. below top, and 2:1 above spillway. The lower slope is 2:1. The upstream slope will be paved with 12 in. hand laid stone on 6 in. of crushed rock blanket. The embankment contains 600,000 cu. yd., and was built with teams in lifts varying from 2 to 4 ft. Each lift was thoroughly "irrigated" to complete saturation. A clay core is carried up in the center, of width equal to the height of the dam above.

half of which is now being con structed. The main canal has 1,00 second feet capacity for 15 miles, i 32 ft. wide at bottom, 8 ft. deep (ft. freeboard in addition) with sid slopes of 2:1.

At the diversion dam twelve 5 f by 8 ft. cast iron hand operated head gates are installed for diverting wate into the canal.

R. A. Thompson is chief enginee of the district and O. N. Floyd, as sistant chief engineer. The work i being done by W. E. Callahan Con struction Co. of Dallas, Tex., genera contractors. The Morgan Engineerin



Diversion Dam, Looking North. View Taken March, 1923.

A steel sheet piling cut-off wall (35 lb. per square foot) is driven in the center of the dam in a trench 12 ft. wide at bottom, side slopes 1:1. The piling is driven to substantial refusal into clay and shale. The longest piling is 43 ft. About 2,225 tons were used. The piling projects some 8 to 10 ft. in the puddle core above.

A concrete spillway of O. G. type and 308 ft. long is being built on the river bank at the south end of the dam. The capacity is 100,000 second feet when 19 ft. deep on the crest. The spillway is set on shale foundation with apron 16 ft. below river bed, and contains about 8,600 cu. yd. of concrete.

The cost of this dam will be about $975,000.

Canal System.—A canal system is projected for 100,000 acres, only one-

Co. of Memphis, Tenn. (L. L. Hidinger president) is consulting engineer fo the bond purchasers.

Growth of City Manager Plan

At the beginning of July there wer 322 municipalities operating under th city manager plan. The followin table from the July City Manage Magazine shows the growth of thi form of city government:

Put in Effect	By Chart.	By Ord.	Tota
1908	0	1	
1912	1	2	
1913	8	3	1
1914	15	6	2
1915	13	7	2
1916	15	5	2
1917	13	5	1
1918	20	9	2
1919	20	11	3
1920	23	16	3
1921	42	11	5
1922	29	13	4
1923	22	12	3
1924	1	0	1
Totals	230	92	32

Coagulation Control by Hydrogen Ion Concentration.

Results of Tests at Various North Carolina Municipal Water Plants Given in Paper Presented May 25 at Annual Convention of American Water Works Association

By G. F. CATLETT,
Principal Assistant Engineer, North Carolina State Board of Health.

At a conference of engineers and filter plant superintendents of the Southeastern States, held at Atlanta in July 1922, Mr. E. J. Theriault described very comprehensively results obtained by the U. S. Public Health Service in a very exhaustive laboratory study of the value of hydrogen ion concentration in the control of coagulation at water purification plants. This study was made for the most part on artificially prepared turbidities and added buffers, though some results were obtained on natural Potomac river water. As described by Mr. Theriault the indications were that this determination would be of the greatest value to the filter plant man in controlling his dosage, so as to secure economy of chemicals, efficiency in filtration, the elimination of coagulant in filter effluent and possibly the prevention of the corrosive action of certain low alkalinity filter plant effluents.

As suggested by Mr. Theriault this laboratory research had reached the stage when the next logical procedure was the application of the same line of investigation to the actual conditions found in the various municipal water plants. With this idea in mind, a series of tests were undertaken by the North Carolina State Department of Health, on the various public water supplies in that state. As the types of water supply found in this state vary from the highly colored swamp waters of the Atlantic Seaboard to the clear mountain supplies of the Blue Ridge, it was felt that conditions were very favorable for such studies.

Method of Making the Determination.—The determination of hydrogen ion concentration by electrical methods was not considered as the apparatus is too expensive for the small water plant and the technique too elaborate for the average operator. For the large plants it is entirely suitable and of course furnishes the most reliable figures. It is also useful for standardizing the color methods.

In order to arrive at a suitable colormetric technique, tests were started at the Wilmington, N. C., plant. Close co-operation and assistance was furnished by Mr. Geo. D. Norcom, the superintendent of filtration. The standards supplied by the LaMotte Chemical Co. were first tried, but were found unsatisfactory as regards permanence, the methyl red range especially spoiling very quickly. Pure chemicals were next secured and buffer solution made, from which standards could be made up as needed. Very good results were obtained in this way, but only a well trained chemist with a good laboratory could be relied upon to make such standards.

In the book, "The Determination of Hydrogen Ion Concentration," by Dr. W. M. Clark, is a color chart reproducing the colors of the various standards, made in accordance with the method of Clark and Lubs. It was found that using these charts in place of the tube standards gave very satisfactory results, that compared very favorably with tubes made from standard buffer solutions and with fresh LaMotte Chemical Co. standards. In order to check possible variation due to personal equation, determinations were made using tube standards and color chart, and by several observers, some of whom had had no previous experience in this class of work. The results showed very close conformity in results and sufficient accuracy using charts for the purpose of water treatment control.

In order to carry out this technique it is only necessary to have one of the charts, which are sold separate from book, some indicator solutions, tubes graduated to hold 10 cubic centimeter, 1 cc. pipette graduated in 1/10ths, and a bottle of distilled water. The indicator solutions are made from the dry powder purchased from LaMotte Chemical Co. and in accordance with Clark's method, except that after rubbing up the dry indicator in a mortar with the specified quantities of N/20

soda, the final dilution was made with 85 per cent ethyl alcohol instead of distilled water. These solutions are 20 times to strong in case of methyl red and 10 times to strong in the case of the other indicators.

It is necessary to make these concentrations in order to secure keeping qualities, and for making the tests they must be diluted with distilled water. The concentrated alcoholic solutions seem to keep almost indefinitely, a set having been used over a period of eight months with no deterioration. All of the tests given in Table I were made by this method, with sufficient checking by tube standards to insure the uniformity of results. It is a significant fact that tests made on the same water at beginning of the eight months showed the same results as at the end of this time, though the same stock indicator solutions were used for entire period. The colors on the charts do not seem to fade appreciably, and they are cheap enough to make their replacement no obstacle.

This technique seems to meet the needs of the small plant operator, and as described forms a much simpler test than the determination alkalinity by titration with acid.

Determination of Optima.—Clark and Theriault (Public Health Reports, Feb. 2, 1923), state that as a result of their investigation:

"When other possible factors are left out of consideration, optimum conditions for floc formation will be found with a narrow zone of pH centered for dilute solutions at pH 5.5." J. R. Baylis (Proc. American Society Civil Engineers, Dec., 1921) gives an optimum for Baltimore city water at 6.5. Wagner and Enslow (Journal American W. W. Association, May, 1922), give an optimum zone for "non organic" waters 6.5 to 7.0 and for "organic waters" a zone as low as 5.7 and never above 6.5. These figures indicate quite a variation in optima.

Tables I, II and III give optima determined on a number of North Carolina waters. Those in Table I check the figure set by Clark and Theriault. These waters are practically all located in the east central part of the state and contain a certain amount of colors as well as turbidity. Table II shows some waters located in the south central part of the state with

TABLE I—WATERS WITH OPTIMUM 5.5

No. Test	Town	Nature of raw water	Alkalinity	Color	Turbidity	pH raw water	Optimum pH
1	Rocky Mount	Tar River	23	20	50	6.4	5.6
2	Rocky Mount	Tar River	21	10	350	6.4	5.6
3	Rocky Mount	Tar River	21	40	80	6.4	5.6
4	Tarboro	Tar River	18	20	50	6.4	5.6
5	Tarboro	Tar River	16	20	300	6.4	5.6
6	Greenville	Tar River	17	30	50	6.4	5.6
7	Greenville	Tar River	19	20	300	6.4	5.6
8	Raleigh	Impounded Creek	17	20	40	6.4	5.6
9	Hickory	Creek	8	10	60	6.2	5.6
10	Salisbury	Yadkin River	18	10	350	6.4	5.6
11	Winston-Salem	Impounded Creek	21	20	100	6.8	5.6
12	Henderson	Impounded Creek	7	0	50	6.4	5.8
13	Wilson	Creek	14	30	40	6.4	5.6
14	Wilmington	Cape Fear River	9	80	200	6.3	4.8
15	Wilmington	Cape Fear River	7	80	20	6.3	5.6
16	Wilmington	Cape Fear River	8	40	150	6.6	5.6
17	Washington	Creek	19	60	60	6.4	5.6
18	Goldsboro	River	7	60	150	6.8	5.6

TABLE II—HIGH OPTIMUM TURBID WATERS

No. Test	Town	Nature of raw water	Alkalinity	Color	Turbidity	pH raw water	Optimum pH
19	Durham	Impounded Creek	21	0	80	6.8	6.6
20	Gastonia	Impounded Creek	21	0	40	7.6	7.0
21	Gastonia	Impounded Creek	20	0	300	7.0	6.6
22	Charlotte	Catawba River	23	0	200	6.8	7.6
23	Concord	Creek	39	0	80	6.6	6.6
24	Wadesboro	Creek	11	0	60	6.6	6.4
25	Lexington	Creek	40	0	60	7.2	7.0

TABLE III—HIGH COLORED CLEAR WATERS

No. test	Town	Nature of raw water	Alkalinity	Color	Turbidity	pH raw water	Optimum pH
26	Lumberton	Lumber River	6	150	30	6.2	6.3
27	Lumberton	Lumber River	0	150	30	5.4	5.2
28	Hamlet	Impounded Creek	7	70	0	6.4	5.7
29	Wilmington	Northeast River	6	250	30	5.9	4.3
30	Wilmington	Northeast River	9	150	20	6.3	5.0
31	Elizabeth City	Knobbs Creek	8	200	20	6.4	4.5
32	Hertford	Perquimans River	....	500	0	5.6	4.8

tima consistent with those found by aylis, and Wagner and Enslow. ese waters are more or less turbid th practically no color.

Table III gives the figures on the gh colored clear waters. The water ed at Hamlet and Lumberton with mparatively low colors, give optima ound 5.5, while the three supplies Wilmington (northeast river), rtford and Elizabeth City, with an cessive color show much lower optna. The first two are located in inrior of the state, while the latter ree are on the coast.

The method used for determining tima on these waters, consisting in ing the ordinary "jar test," and apying the results obtained with this the plant itself. A series of 1 liter rs are used, and alum, soda and lime lutions prepared so that each cubic ntimeter of alum solution put in a r of raw water would be equivalent ½ grain per gallon, and each cubic ntimeter of alkali solution in same ay was equivalent to ⅛ grain per llon. In this way any combination of chemicals could be used. The pH was then determined on each jar test, and the jar furnishing a floc most quickly was considered optimum. In this connection it may be noted that the observation of Clark and Theriault, that the quickest forming floc is always eventually the best floc, was borne out in these tests.

On waters where there was sufficient natural alkalinity to react with the alum, the determination of the optimum is a simple matter, as it is only necessary to run a series with various amounts of alum. Where there is required additional alkalinity the tests were complicated by the two variables. In the latter case a series of jar tests must be made for each quantity of alum, with the amount of alum the same in each jar and added alkali varied. In each case the pH is carried to a point on acid side where no floc forms after hours, and similarly on the alkali side to a point of no floc formation.

Tables IV, V and VI will illustrate a typical set of tests.

TABLE IV

o. Test	Alum g.p.g.	Alkali p.p.m.	pH	Floc
1	0.5	0	6.2	none
2	1.0	0	6.0	poor
3	1.5	0	5.6	excellent (optimum)
4	2.0	0	5.2	slow
5	2.5	0	5.0	none

TABLE V

o. Test	Alum g.p.g.	Alkali p.p.m.	pH	Floc
1	3.5	10	4.8	none
2	3.5	14	5.2	poor
3	3.5	18	5.4	excellent
4	3.5	22	5.6	excellent
5	3.5	28	5.8	good (slow)
6	3.5	30	6.0	good (slow)
7	3.5	32	6.0	poor (very slow)
8	3.5	36	6.4	very poor
9	2.0	6	5.2	fair
0	2.0	8	5.4	poor
1	2.0	10	5.6	fair (optimum 2 grs. alum)
2	2.0	12	5.7	fair
3	2.0	14	5.8	fair
4	2.5	8	5.0	poor
5	2.5	10	5.2	poor
6	2.5	12	5.4	poor
7	2.5	14	5.6	good
8	2.5	16	5.7	good
9	2.5	18	5.7	good
0	2.5	20	5.8	slow
1	2.5	24	6.2	slow, fair
2	2.5	28	6.4	fair, smoky
3	2.5	32	6.6	fair, smoky
4	2.5	36	6.8	poor
5	2.5	40	6.8	poor

TABLE VI

o. Test	Alum g.p.g.	Alkali p.p.m.	pH	Floc
1	2.0	0	5.8	none
2	2.0	6	6.0	none
3	2.0	12	6.2	none
4	2.0	16	6.3	poor
5	2.0	20	6.4	poor
6	2.0	30	6.6	excellent
7	1.0	15	6.6	excellent
8	1.0	10	6.4	poor

The alkalinity of the raw water was 21 which was sufficient for necessary alum. If sufficient alkali had been used to bring pH on No. 5 test to 5.5 an excellent floc was formed. This is the water designated No. 1 in Table I.

This water is the one listed in table 3 from Hamlet. It has fairly high color and no turbidity.

This is the water listed in Table II as Concord. It will be noted that there is no color and the natural alkalinity is 39.

The tables IV, V and VI will give an idea of how each test was carried out.

High Optimum Waters—It is rather difficult to offer explanation of the high optimum water. The chemical contents not differing appreciably from those with lower optima. An important fact, however, is that there is quite a difference in the alkali requirements on these waters from that of the 5.5 series. It is generally true that the latter require about 6 parts per million for every grain of alum per gallon. In the case of the waters at Charlotte, Concord, Gastonia, Wadesboro, etc., in Table II, although there is found more than enough natural alkalinity to react with the alum added, it is necessary to add excessive amounts of alkali to get a good floc. In the case of Charlotte the raw water alkalinity was 21 p.p.m. and this should be entirely sufficient for 2 grs. per gal. of alum. However, it was necessary to add 30 p.p.m. additional alkalinity to get the best floc. It was not possible to get CO_2 determinations on the various waters, but at Charlotte and Wilmington these are recorded daily and do not show appreciable difference.

High Colored Water—The high colored waters show low optima. The excessively high colored waters at Wilmington, Elizabeth City and Hartford require optima as low as 4.5, while partly colored waters at Hamlet and Lumberton may run as high as 5.6. The water at Wilmington has been especially studied, Mr. Geo. D. Norcom, in charge of the filter plant, having made numerous pH determinations during the last year. This is typical of the high colored waters, and a low alkalinity treatment was worked out for it by the author in 1916, and is still in use. This treatment consists in adding only enough alkali to give 4 p.p.m. for each gr. per gal. of alum, and adding additional alkali in a second basin, the principles involved in the precipitation of colloids prompting this treatment as explained at that time. The Elizabeth City water and that at Hertford act similarly.

A very interesting condition exists at Wilmington. Just below the filtration plant, the Cape Fear river forks forming the main Cape Fear and Northeast branch. The main river usually is a low colored high turbidity water, while the Northeast branch is highly stained from cypress swamps. Up to very recently water has been taken from the Northeast branch, where the tidal changes furnish a clear colored water at times and others a mixture of this with the main Cape Fear water. The tests on the Wilmington water under Table 3 are made on this colored Northeast water and show an optimum of about 4.5. Recently the intake was extended across to main river, and the Wilmington tests under Table I are made on the new water. Thus we have the main river showing an optimum about 5.5 and its branch fed from Cypress swamps showing the lower optimum.

Controlling the pH by Adding Acid—In the case of the Tar river waters tests 1-7 in Table I, sulphuric acid was used with the result that as good floc was formed using 0.5 grains per gal. alum as where 1.5 grains was required without acid. It was necessary to add 1.5 g.p.g. alum before the optimum of 5.6 was reached and by adding just sufficient sulphuric acid to produce a pH of 5.6 with 0.5 g.p.g. alum similar results were accomplished.

All attempts to cut the pH of the high colored waters down with sulphuric acid, thus reducing the amount of alum required, were unsuccessful.

A Colloidal Clay and Color as a Reason for Variable Optimum.—A possible explanation of the variable optimum lies in the colloids in the water. Clay in colloidal state has a negative electric charge and color a positive charge. The fairly heavy clay particles have no influence. The whole process of coagulating water has two stages. This first reaction is entirely a chemical one where definite amounts of alkali combine with definite amounts of aluminum sulphate with the formation of aluminum hydrate. Even with the tests where the pH is too high or too low and no good floc is formed, there is except when too little alum is used

a high colored water, a smoky pearance showing the formation of minum hydrate. This aluminum drate is held in a colloidal state d must be thrown down by physical ans. There seems to be required a finite pH or definite electrical arge to precipitate the positively arged aluminum hydrate and negaely charged coloring matter and y particles.

Value of pH in Plant Control.—us far the practical application of e pH determination indicates valble assistance to the plant operor. Having determined the optiim pH, it is only necessary to take mples of water from the mixing amber and determine the pH. If low the optimum more alkali ould be added and if above optimum kali is reduced. If supposed optium is shown and poor floc is formig, it would suggest a change in timum, and a redetermination of is made. Our experience so far ows that the optimum does not ange very frequently. In the case the Tar river tests (Table I—tests 3) the first test was made in August ter a long dry spell, the second st was in October after heavy rains d the third in February during cold ather conditions. In each case the timum was the same.

Our experience also indicates that agulation taking place at the optiim pH, gives a heavy, well defined c, and that it takes place more pidly, thus requiring less mixing amber and coagulation basin retenn time. Attention is especially lled to the influence of this control coagulation on mixing chamber sign.

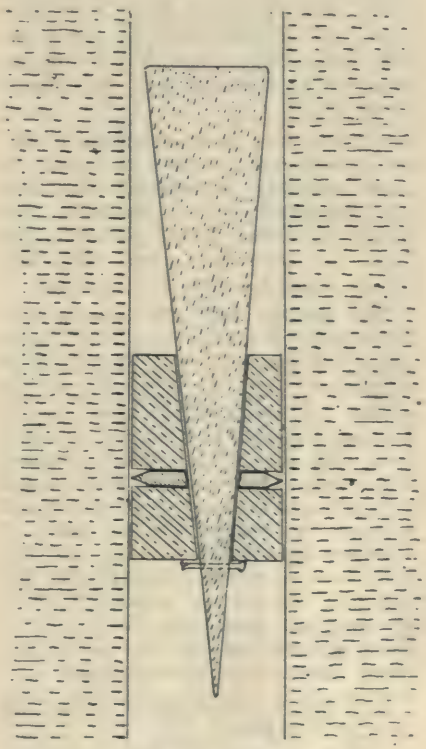
Conclusions.—The majority of wats in North Carolina coagulate most tisfactorily at an optimum pH of proximately 5.5. High colored ters require a much lower optimum proximately 4.5 pH. Some turbid ters, free from color, have a much gher optimum varying from 6.5 to pH.

A technique sufficiently simple for e average small plant operator may devised for determining hydrogen n concentration in water purificaon control.

Experience on a number of waters North Carolina indicate that the I determinations furnish a very valble assistance in securing more efctive and economical results.

Method of Stopping Flow of Water From a Bore Hole

In drilling a 3-in. hole with a hand diamond boring set to prove the existence of lower seams at a coal mine in England, a large flow of water was struck. This water drained off to a sump where a 50-gal. per minute pump was in use. This was soon unable to handle the rush of water and steps were taken to



Sketch of Plug.

plug the bore hole. How this was accomplished is told in Water and Water Engineering, London:

The boring rods were drawn and an attempt made to stop the outburst, which was shooting up and striking the roof with no mean force. Pieces of the core were dropped into the hole, but they simply bobbed up in the stream.

Wooden plugs were tried, driven in by a weight raised and allowed to fall by a rope over the headgear

pulley. These were soon burst out. The pressure of the water had been ascertained to be 102 lb. per sq. in.

Successive wooden plugs were tried, driving in one after the other, the first plugs having a slit along their length to allow the escape of water. The slit in the proceeding plug was made smaller, and so on, and by alternating the position of the slit the hole was in a way completely closed. But only for a short time. The series of plugs were also burst out. Pieces of chain and scrap iron were put into the hole in an endeavor to stop the flow, but it was of no avail.

A pipe was then grouted in and an attempt was made to force in liquid cement. It seemed as if this was going to succeed, but after the flange had been bolted on for some time, the pavement gave way and things were soon as bad as ever.

The method that did succeed was as follows: A lead plug was made after the fashion of a cartridge of gunpowder, with a conical hole in the centre. A round tapered bar of iron was put through the centre and solid rods with a sledging piece lowered down behind. When the plug rested in the hole, the rods were raised and lowered to strike the round piece of iron through the lead plug and expand, so as to completely fill the borehole. It did not, however, retain its grip on the sides of the hole, being forced up by the water and down again when it was struck.

This led to the idea of projecting pins in the plug.

Two recesses were made in the sides for steel pins. These were kept flush when lowering, but when the tapered rod, which was through the plug, was struck and driven further in, these steel pins were forced out and into the sides of the borehole, retaining it in its position. Thus held, the centre pin was driven through the plug, expanding it and finally closing the hole. When this had been well pounded down, the flow of water had nearly ceased, and it was now possible to have the hole filled with cement and the trouble was ended.

The New 80-Ton Choutea Ave. Incinerator Plant, St. Louis, Mo.

Extract From Report of C. S. But Engineer, Department of Public Utilities, St. Louis

The foundation consists of 49 20-f reinforced pre-cast concrete pil driven to an elevation of 95.5, bein 6 in. in the concrete footings, whic are constructed to an elevation 103.2, 1 ft. above the operating roo floor level. The outside dimensions the building are 38 ft. x 56 ft. 1 i built of brick with steel truss roo The operating floor is on an elevatio of 102.2, being 36 on river gauge.

Operating Floor.—A small office ft. x 12 ft. and a wash and toil room 6 ft. x 12 ft. with shower a on this floor. Three furnaces (inclu ing combustion chamber) 14 ft. 9 i x 32 ft. long by 11 ft. 6 in. high a built on this floor. Two forced dra fans, one 10 h. p. and one 20 h. p placed on floor at north end of fu naces for furnishing the furnaces wi forced draft.

Tipping Floor.—The tipping floor built on an elevation of 123.2. The are three holes 3 ft. x 3 ft. and thr holes 1 ft. 6 in. x 4 ft., which t garbage is dumped into and goes d rectly into a storage bin (the enti length of furnaces), which is t angular shaped, 9 ft. 6 in. deep, wi capacity for 60 tons of garbage. A other hole 5 ft. 6½ in. x 4 ft. 2 in. left directly over the combustio chamber for incinerating dead an mals. There are also two coal hole 1 ft. 6 in. x 2 ft. each, for dumpin coal into chutes which empty on t operating floor in front of the fu naces.

Clinker Pits.—There are two trac 24 in. gauge with dump cars to r ceive the clinkers from the furnace and dust from the combustion char bers. The space occupied by pits 11 ft. 6 in. wide by 32 ft. long an 7 ft. high. These tracks lead out the south end of the building, then to the river bank.

Trestle Approach.—The trestle a proach leads out of double doors the tipping floor to the south. Th entrance to the plant being by Co vent St., a scale is located on t

pproach direct to tipping floor. A ft. x 125 ft. radial brick chimney is ıilt upon 25 25 ft. pre-cast concrete ıles and a reinforced concrete slab 7 ft. x 17 ft. x 4 in. The chimney lined with fire brick 9 in. for 50 ft., ½ in. for 55 ft., making a total of)5 ft. of lining.

Operation of Plant.—The garbage hauled up the incline, passing over ıales, where it is weighed, thence to the south end of building onto ıe tipping floor where it is dumped holes in floor into a large storage n holding about 60 ton. There are openings left in the east side of bin ith steel doors operated by pulleys ıd weights. Immediately opposite ıch door is a hole 2 ft. 1 in. in ıameter closed by a cone-shaped eight which is also operated by pulys. Outside of this hole are other eel doors, making a closed air lock. he garbage is raked from the storge bin into the 2 ft. 1 in. opening at p of furnace, thence diverted onto a ying arch from which it is raked ıto side grates where it is further ied, thence raked into the fire box the furnace. The side grates are ft. long by 3 ft. 6 in. wide. The ke box proper is 2 ft. 3 in. wide, ft. 3 in. deep and 5 ft. long, making total of about 60 sq. ft. of grate ırface. After garbage is burned the hes and clinkers are drawn into an h bin and when cooled off are loaded to small cars in basement of plant ıd dumped in river. The furnaces e operated with forced draft, being pplied by two fans, one 10 h. p. and ie 20 h. p., the air to supply these ıns is taken out of each of the three h bins, over the hot clinkers into a in. vitrified pipe, then into an air ıamber 3 ft. x 6 ft., thence through e fans into two galvanized air-tight ıcts, one 1 ft. 6 in. x 2 ft. and one ft. 6 in. x 3 ft. under the furnaces. r is also taken out of the garbage ı through a 20 in. galvanized pipe rough the fans and into the ducts. ıder each furnace and directly under e grates are three 12 in. diameter les in the ducts and are raised 12 in. ove top of same. Two of these holes pply air to the side gates and one the fire box, the supply of air being gulated by dampers over each hole. ıe fans are so connected and dampıs located in the air pipes proper, that they can draw from ash pits, mbustion chamber and garbage bin separately and can be operated singly or together. The gases from the furnaces pass through a large combustion chamber where a temperature of about 1200° is maintained. Dead animals can be cinerated in this chamber. The chamber connected to the chimney, which is 5 ft. in diameter by 125 ft. high. All gases and mal odors disappear before reaching top of chimney.

In connection with the plant a 280 gal. tank is provided for hot water, being supplied by two 2 in. pipes placed in the combustion chamber. This hot water furnished two radiators in office and toilet rooms and also furnished hot water on tipping floor and firing floor for cleaning purposes.

The building was constructed by local contractors and the furnaces were constructed by the Burke Furnace Co. of Chicago. The plant is being operated by the Department of Streets and Sewers, Clinton H. Fiske, director.

Guarantee.—The guarantee made was as follows: To incinerate 80 tons of garbage in 24 hours without any nuisance or mal odors; to use not over 8 k.w. electricity for forced draft fans per ton of garbage; to use not more than 6 per cent or 120 lbs. of coal per ton of garbage. Tests show that this capacity has been raised to at least 100 ton in 24 hours and that it required less than 1 k.w. electricity for each ton of garbage and less than 100 lbs. of coal per ton of garbage. It has therefore more than fulfilled the guarantee.

The plant is being operated 24 hours per day in three 8-hour shifts and requires three men on the firing floor, three on charging floor and one foreman for each 8-hour shift, and is incinerating garbage without any offensive odors or smoke for $1.00 per ton or showing a saving of $1.10 per ton over the present contract of dumping it on barges at $2.10 per ton.

Population in Illinois Supplied With Purified Water.—The population in Illinois supplied by the 39 water-purification plants, on the basis of figures given by the 1920 census, amounted to 589,385, by the 13 sterilization plants, 3,074,000 (including Chicago), and by the iron-removal and softening plants 53,515, making a total population of 3,697,231 supplied by artificially treated water.

Behavior of Concrete Exposed to Alkaline Conditions

Investigations, Their Results and Present Status Outlined in Pape Presented June 29 at 26th Annual Meeting of American Society for Testing Materials

By G. M. WILLIAMS

Professor of Civil Engineering, University of Saskatchewan, Saskatoon, Canada

The deterioration of concrete in the so-called alkaline soils has received prominence during the last 15 or 20 years, following the development of irrigation in the Western states. In numerous instances, irrigation structures, foundations and other concrete works have shown signs of failure after short exposure to the salts in the soil. Various theories as to the cause of deterioration were advanced and it was first believed to be due to the crystallization of the soluble salts in the pore space of the concrete, which action was greatly accelerated by the use of poor aggregate and poor methods of preparation and curing. The problem was further complicated by the fact that not all concretes exposed to apparently similar conditions were attacked, tending to substantiate the theory that aggregates and workmanship were to blame. The possibility that the deterioration was primarily due to reaction between the salts in solution and constituents of the cement was also advanced but was not generally accepted owing to lack of experimental verification and the knowledge that materials and workmanship were of inferior quality in some cases.

Deterioration Due to Alkali.—Deterioration due to alkali has generally occurred in the arid or semi-arid sections of the Western states. The weathering and breaking down of rocks by long exposure to the elements has resulted in the formation of soil, and the salts of sodium, calcium and magnesium which were once among the constituents of the rocks are now found distributed throughout the soil, usually in greatest amount in the clays and shales. While most ground waters carry in solution appreciable quantities of one or more of these salth, it is in the arid regions that concentrations are sufficiently high to result in such waters bein classed as alkali waters.

In the humid region, heavy rainfal for many years has washed most o these salts from the soil, but in th arid and semi-arid districts, a smalle rainfall together with soils less easil drained have resulted in the condi tions as now found. The excessiv application of irrigation water, to gether with poor drainage facilitie has resulted in a gradual raising o the soil-water level which has brough about a high concentration of salts a the ground surface and a few fee below.

It is this condition which is respon sible for most cases of disintegratio that have been noted, although ther are localities outside of the irrigate sections where surface concentra tions of salt are small and deterio ration occurs some distance belo near the surface has no doubt bee accelerated by frost action, bu action is generally absent.

Investigations Prior to 1910.—Investigations to study the cause o deterioration were started in thos localities where the trouble was firs encountered. The discovery, at abou the same time, of disintegration o cement drain tile in Colorado[1] an of concrete sewers and culverts a Great Falls, Mont.,[2] led to labora tory studies by State Agricultura Colleges of Colorado and Montana Soon after, the Structural Material Laboratories of the U. S. Geologica Survey, then located at St. Louis investigated conditions on irrigatio projects in South Dakota, Wyoming and Montana and found cases o disintegration of concrete as well a stones and brick.

The conclusions drawn from these early laboratory investigations ar well summarized by the followin

[1] *Bulletin No. 132,* Colorado State Agricultural College.
[2] *Bulletin No. 81,* Montana State Agricultural College.

otation from Bulletin No. 81 of ontana State Agricultural College: "The disintegration of cement by kali salts is principally due to action between these salts and the cium hydroxide necessarily present set cement. As a result of these actions relatively insoluble new mpounds are formed in the body the cement structure. These new mpounds have greater weight and quire greater space than the (OH) replaced. New compounds ce apart the particles of cement, s awakening or breaking the ding material."

A combined field and laboratory vestigation[3] of the effect of both kali soils and sea water upon portnd cement was undertaken by the ructural Materials Laboratories of e Geological Survey, and later nsferred to the U. S. Bureau of andards. The conclusions drawn ay be summarized briefly as follws:

"Portland cement mortar or conete can be disintegrated by meanical means exerted by the ystallization of almost any salt in pores if a sufficient amount of is permitted to accumulate and a pid formation of crystals is brought out by drying. Porous stone, ick and other materials are disegrated in the same manner. In e presence of sea water and simr sulfate chloride solutions the st soluble element in the cement the lime. If the lime of the ment is carbonized it is practically soluble."

In both of the foregoing investitions, which were completed prior 1910, it is concluded that deterication is not due alone to mechan and physical disintegration, but the dissolving effect of the soluble ts on constituents of the cement. at portland cement could be disegrated in the laboratory was ll established, but it was also recnized that laboratory conditions re not in every way comparable th those encountered in actual actice.

The Bureau of Standards' First tensive Field Investigation.—The st extensive field investigation[4] s that undertaken by the Bureau Standards in 1913. This involved the manufacture in a commercial factory of sixteen varieties or types of 8-in. cement drain tile and shipment of a carload to each of eleven localities, in eight of which severe alkali conditions would be encountered. These tests of drain tile were later supplemented by the installation of concrete blocks in eight districts in the west. The ground waters in these districts varied considerably in concentrations and constituents, but in most cases the sulfates predominated. In one or two instances the quantities of chlorides and sulfates were practically equal. Sodium or magnesium was the base usually present in greatest quantity, with much calcium in a few cases.

This investigation, comprising as it does concretes and mortars of the highest quality and identical specimens exposed in widely separated districts, has resulted in confirming and extending the conclusions drawn in the previous studies. These may be summarized as follows:

1. The best quality of mortar or concrete may be disintegrated in sulfate soils and waters. The deterioration in chloride or carbonate waters appears to be very slow or almost entirely lacking.
2. Rapidity of disintegration is proportional to the sulfate content of the water.
3. Frost action appears to accelerate disintegration in sulfate waters.
4. Carbonizing of the lime at and near the outer surface of a structure will not prevent disintegration. While this carbonized coat may be immune or very slowly affected, it is permeable and the uncarbonized portions within may be attacked and result in the shelling off of the carbonized surface.
5. Tar protective coatings are not permanent.
6. Concentrations of alkali waters may vary as much as several hundred per cent in distances only a few feet apart.

Field Investigations in Canada.—The alkali-concrete problem of the Western states is also encountered in the Prairie Provinces of Canada. In 1918, the Calgary Branch of the Engineering Institute of Canada

[3] U. S. Bureau of Standards, *Technologic Paper No. 12.*
[4] U. S. Bureau of Standards, *Technologic Papers Nos. 95 and 214.*
[5] *Journal,* Engineering Institute of Canada, September, 1921.

started a field investigation[5] by exposing blocks of different qualities of concrete, some of which were coated with various surface preparations, to sulfate waters. Observation of changes taking place has led to practically the same conclusions as were drawn from the Bureau of Standards' study.

In 1919, test specimens were prepared at the University of Saskatchewan and exposed to sulfate waters at Saskatoon. Here the water was encountered at a depth of 6 to 8 ft. below the ground surface, thereby eliminating possibility of frost action in the tests. Good quality of concrete was affected and in one instance an inferior quality a small distance away was apparently unaffected. Analyses of the soil waters showed a much higher concentration surrounding the higher quality concrete.

In 1921, the Structural Materials Research Laboratory of Lewis Institute commenced an extensive field investigation by installing concrete specimens of widely different qualities in two alkali districts in the United States and supplemented by the exposure of smaller groups in three districts in Western Canada. While sufficient time has not elapsed to draw definite or final conclusions, the results obtained after one year's exposure are very similar to those found in the same length of time by the previous investigations.

The Second Phase of the Investigation. — All of the foregoing investigations may be considered as establishing the first phase of the investigation — definitely fixing the problem — and demonstrating the fact that disintegration is primarily a chemical action, rather than a physical disruption, and indicating the variable factors and conditions which must be met in practical work. The second phase of the work involves the discovery of means, materials and methods for eliminating the possibility of disintegration in future work. Two distinct methods of approach are available. It is possible that a continuation of the field studies by the preparation of many different concretes containing various materials may lead to the production of a concrete which will be immune to attack. The second method is to study in the laboratory the constituents of cement and th reactions which take place whe they come in contact with the di ferent salts found in the soil. This of course, requires a study of th reactions involved in the hardenin and setting of cement, which in itsel is a subject concerning which muc is yet unknown. This second metho is the scientific method of attack an will no doubt be more effective tha the former.

A Committee on Deterioration o Concrete in Alkali Soils, appointe by the Engineering Institute o Canada in 1921, after considerin the conclusions reached by previou investigators, decided that little fur ther progress could be made by fiel studies and that its energies shoul be mainly directed towards a stud of the chemical reactions involve As a result, only sufficient field wor is being done to try out in a practic way a number of waterproofing an alkaliproofing compounds which ar now on the market, while th greater portion of a $40,000 fun contributed by the Research Counc of Canada, the Prairie Province cities and interested corporations being devoted to chemical researc While it will be some time befor definite results can be expected fro the chemical research, it is interest ing to note that conclusions draw from previous investigations as t the action being primarily chemica have again been verified. No ne conclusions are as yet available fro the field tests except that the re sults obtained with admixtures an integral compounds have withou exception been discouraging, whic further emphasizes the committee' decision that all efforts at presen should be directed toward the chem ical research.

Additional investigative work whic should add much to our knowledg of this problem is that now bein conducted in connection with th work of the Society's Committee C- on Drain Tile. At Iowa State Col lege the effects of various salt solu tions on mortars are being studied while the Drainage Division of th U. S. Bureau of Public Roads, i cooperation with the state of Min nesota, is doing much to improve th quality of drain tile in that stat where deterioration of cement til has occurred.

Status of Use of Concrete i

lkaline Soils.—The status of the se of concrete in alkaline soils may e summed up briefly as follows:

1. In many districts of the Westrn states and Canada there are reas where the salt content of the oil is high and concrete cannot be sed with assurance of success.

2. Study of field conditions indiates that deterioration of concrete ructures is almost entirely confined regions where the sulfate type redominates. Good quality concrete apparently being successfully used chloride and carbonate soils.

3. Rapidity of disintegration vaes directly as the sulfate concentraion.

4. Where concentrations are perhanently low, good quality concrete ppears to have a life which fully ustifies its use.

5. Concentration of salt in ground ater may be extremely variable at oints short distances apart. There lso appears to be seasonal or yearly ariation in some districts.

6. Concrete of high quality is ost resistant to action. High qualy for exposure to alkaline condions is measured by impermeability resistance to passage of water rough the mass under pressure. he one big factor necessary to cure low permeability is high cent content, so that high compresve strength can generally be used a criterion of low permeability. onsistency, within practical workg limits, and gradation of aggreate are secondary factors in obtaing a concrete of low permeability.

7. Where alkali conditions are d, the factor of safety against ilure can be greatly increased by nploying proper drainage precauons.

8. The employment of a memane waterproofing may prevent tion for a time at least, but such method is not practicable under l conditions.

9. Portland cement, as now conituted, is inherently subject to tack by sulfates in the soil and round water and the practical and nal settlement of the alkali-concrete roblem is dependent upon modificaon of, or the discovery of some aterial which may be added to, ortland cement to make it immune such action.

New Development in Apprenticeship Training

A novel scheme for the training of apprentices has been worked out by the Associated Tile Manufacturers, the Tile and Mantel Contractors' Association of America, and the Bricklayers', Masons' and Plasterers' International Union of America, according to the Weekly Bulletin of the National Association Building Trades Employers. The plan provides for 20 scholarships at the Dunwoody Institute, Minneapolis, Minn., for a period beginning June 4th and ending Aug. 31st, the entire cost of which will be borne by the Associated Tile Manufacturers. One scholarship will be awarded in each of the following cities to the candidate selected by the local Joint Arbitration Board of the Tile and Mantel Contractors' Association and the Bricklayers', Masons' and Plasterers' International Union of America: Atlanta, Baltimore, Boston, Buffalo, Chicago, Cincinnati, Kansas City, Louisville, Milwaukee, Cleveland, Denver, Detroit, Duluth, Minneapolis, New Orleans, Omaha, Pittsburgh, Philadelphia, St. Louis and Washington.

Each scholarship includes carfare to and from Minneapolis, $10 per week for 13 weeks to cover board and room; all tuition and text material; use of all tools needed and construction materials. All candidates for scholarships must be over 16 years of age and under 25, and must have a medical certificate showing their physical fitness to follow the trade.

All candidates must be without previous experience or training in tile setting or helping and agree to serve out his apprenticeship of three years with the agreement that the successful completion of the three months' course at Dunwoody Institute will be recognized as the first six months of such term.

A course of instruction has been worked out which will furnish the apprentices with the fundamental principles of the trade, and if carefully followed should result in developing unusually high type workmen.

Higher Steam Pressures and Improvement in Station Economy

A Paper Read at the 1923 Convention of National Electric Light Association in New York

By F. H. BUSHNEL

Development in the art of steam power production is just now proceeding with such rapidity that it is somewhat difficult to preserve a clear conception of its progress. However, the measure of station economy which it already promises can be expressed in the slogan—a kilowatt hour for a pound of coal. Designers of power stations and of station equipment are now entirely confident of attaining this mark. They feel that the means for its accomplishment have finally presented themselves, and that only the perfection of detail is now required. One of these means is the use of much higher steam pressures than have heretofore been considered practicable.

Following the general replacement of reciprocating engines by turbines, which first made the use of relatively high steam pressures and temperatures really practically on a large scale, there were many years during which a pressure of 200 pounds and a total temperature of about 500 degrees were looked upon as standard for even the largest installations. It is but two or three years since the advance to 350 pounds and 700 degrees made it appear that the limit of efficiency was being closely approached. Even within the past year, the discussion of improvement has centered largely about the arrangement of auxiliaries rather than about more basic changes. Now, and with some suddenness, we are made to realize that the development of materials and methods will permit the use of two or three times the customary steam pressures and that the higher efficiency theoretically permitted by such pressures may be realized without involving temperatures which are unsafe for our materials. Higher pressures can be provided for—higher temperatures which must await further development in metallurgy.

It has long been appreciated that the percentage of the total heat in steam theoretically available for conversion into work, continues to increase with rising pressure up to extremely high pressures, although a decreasing rate. This advanta cannot, however, be fully realiz while using the customary straig condensing cycle, as the efficien with which the turbin can utilize t available heat falls off quite rapid with the increasing pressure. T economical compromise between the two conflicting factors indicates th there is little net advantage in e ceeding pressures of 350 or 4 pounds while using the customa cycle of operation. If it were pra ticable to supply the high pressu steam at a sufficiently high initi temperature, straight condensing tu bines would doubtless continue maintain a satisfactory efficiency u der the higher initial pressure. Wi the practicable temperatures definit ly limited, the increased range of e pansion causes the steam to becon saturated too early to permit t lower stages of the turbine to pe form their function most advantag ously.

The obvious method of preventi too early saturation is to restore t temperature of the steam by passi it through a reheater at an inte mediate point in its expansion, th maintaining favorable conditio throughout the turbine, and permi ting the advantage of high pressu to be realized. Although this meth is similar in some respects to the u of the reheating receiver in conne tion with reciprocating engines, differs greatly in that the addition heat is supplied directly from t furnace instead of through the me ium of steam. The method is ne only in its application to the proble of utilizing higher pressures.

As a sequence to these develo ments, it is already being definite planned to use steam pressures up 1,200 pounds in commercial install tions. We are even informed, throug the technical press, that for an e perimental plant in England, stea is to be generated at the critical pre sure of 3,200 pounds, where water an steam are one.

We are asked for assurance th the pursuit of higher efficien through higher pressures is procee ing along lines which are reall sound and that this new developme promises to secure greater econom in dollars as well as to satisfy t engineers' pride of performance. W are confident that such assuran may be given. Our boilermakers ar

ine builders do not question their ity to produce reliable equipment generating and utilizing steam up t least 1,200 pounds. There is no posal to exceed temperatures ch materials have not already ved their ability to withstand. ely our station designers may be ted to provide the remaining re- ites of proper coordination and ngement. An analysis of the re- ements shows no problems of a ibitive nature, nor any measures ch may be termed too experiment- or commercial application.

order to be economically war- ed, any station improvement t show an operating saving ter than the increase in carrying rges which it occasions. There strong indications that the em- ment of higher steam pressure meet this requirement in a way is almost without precedent. The l cost of a high pressure station mises to be comparable with that a station of equal generating ca- ty using the lower pressures now idered standard. The anticipated ng in operation should therefore practically a net saving. This re- s from the fact that the extra of heavier construction or addi- al equipment required for the use he higher pressure will be largely terbalanced by the additional acity which is made available. kilowatt output per rated boiler se power will be greatly increased. ng will be thicker, but smaller in

must not be inferred that all of improvement is to come without acle and effort, or that any one ngement will fit all load condi- s, or that the initial installations leave nothing to be desired. re is already a variety of arrange- ts offered for utilizing the higher sures in conjunction with the re- ing cycle. We may choose be- en a single turbine arranged for action and return of the reheated m, and tandem arrangement with and low pressure turbines driv- the same generator, and the cross- pound arrangement of two or e distinct units which may be er adjacent or widely separated he station. Problems of design n to demand that the pressure the single reheating unit be ted to 500 or 600 pounds. For her pressures one of the other two angements is probably to be preferred. The efficiency of the cycle demands that the reheating be accomplished with the lowest possible loss of pressure and this requirement accordingly has an important bearing upon the arrangement selected. Control of the temperature of the reheated steam must likewise be carefully provided for, especially where a varying load is to be carried. In one arrangement promising reasonable flexibility as well as the highest efficiency, a relatively small and simple high pressure turbine will, for each individual boiler, reduce the pressure of the steam from 1,200 pounds to 375 pounds and deliver it through a reheater, in the same boiler setting, to a main header supplying turbines of the present standard type. Some variations of this method are already being considered for extending or rehabilitating existing stations.

There is no intention to imply that high steam pressure alone will be responsible for all of the promised improvement in station economy. Heating of the feed water by multi-stage bleeding of the main turbines is an important measure still remaining to be fully applied. Auxiliaries must be more carefully selected to reduce their power demand at all station loads—and such power should be derived from the main turbines where it is most economically produced. The design of stokers and furnaces and the arrangement of heating surfaces in boilers, superheaters and economizers, have shown marked improvement. Improvement in stokers and the development of pulverized coal equipment now permit all commercial grades of coal to be burned with surprisingly high efficiency.

As the means for securing higher economy have increased in number, there has also been an increase in the complexity of their interrelation. More than ever will the over-all result depend upon their proper coordination for the conditions to be met. By utilizing these available means and with their harmony of operation assured, the performance of even a 350 pound station may, under favorable load, approach within a fair range of the immediate goal which we have set. It is by adding the further improvement of about ten per cent, which calculations promise for the change to 1,000 pounds pressure and the reheating cycle, that we may deliver a kilowatt hour for a pound of good coal.

Effect of Industrial Wastes on Water Supplies

Progress Report of Committee Presented May 24 at Annual Co vention of American Water Works Association

With the rapid growth of industries the injurious effects of industrial wastes on water supplies and water purification processes are becoming more and more important. Serious trouble from this source has already been experienced in numerous places, as this report shows.

Effect on Public Water Supplies.—Certain wastes, alone or in combination, may have beneficial effects on the water supply by disinfecting action or clarification, but most industrial wastes are detrimental to water supplies. The injury depends upon the character and relative quantities of the substances discharged, with effects which may be classified as follows:

1. Suspended or colloidal mineral matters which increase turbidity and add to the difficulty and expense of coagulation or of filtration, as, for example, coal and ore washing wastes.

2. Dissolved mineral matter impairing the quality of the water and increasing the difficulty and expense of water purification, as, for example, acid mine drainage and salt water from oil wells.

3. Vegetable and animal organic matters in solution or in suspension, which increase the color, turbidity, suspended matter and bacterial content, thereby increasing the difficulty and expense of water purification, as, for example, beet sugar refinery wastes and tannery wastes.

4. Taste and odor producing substances, either organic or mineral in nature, as, for example, phenols in the wastes from gas and coke manufacturing, and sulphite liquors from paper pulp mills.

5. Substances, either organic or mineral, tending to stimulate growths of organisms and thereby increase the difficulty and expense of treatment, as, for example, organic sulphur compounds in wool scouring wastes, and mineralized nitrogen from oxidation of organic wastes of various kinds.

6. Harmful bacteria, as, for example, the anthrax bacilli in tannery wastes.

7. Poisons, as, for example, cyanide from the cyanide process of gold e traction.

The committee has obtained info mation through a questionnaire fro public officials, water works manage and other sources indicating that 2 water supplies, widely distribut throughout the United States a Canada, have been affected by indu trial wastes. The information o tained is valuable but incomplete.

Sugar Refinery Wastes.—T water supplies of Defiance, Napole and Toledo, O., derived from t Maumee River, encountered disagre able tastes and odors during the wi ter months of 1920 when the strea was completely frozen over. T trouble was attributed to oxygen c pletion and anaerobic decompositi of vegetable organic matter, believ to be due in large part to wastes fro beet sugar refineries. Color and b teria in the river water increased a ordinary purification facilities, i cluding storage, aeration, filtrati and chlorination, were only partia effective.

Along the same line the Michig Department of Health reports f killed and offensive odors created the Raisin River below a large b sugar plant, though no water su plies were affected in this case.

Coal Washery Wastes.—In 18 the pollution of the Philadelpl water supply by finely divided c and dirt from washing of anthrac coal was a subject of litigation. Wa from some of the coal washeries c tained over 63,000 parts per mill of suspended solids. Other water su plies in the anthracite regions Pennsylvania and West Virginia a in the southern bituminous fie have been affected in a simi manner.

Acid Wastes From Coal Mining. The acid wastes from coal min operations, by reason of the numl of supplies affected, probably outra all other sources of industrial pol tion. In Pennsylvania alone it is es mated that over 850 million gallons water are pumped each day from t mines of anthracite field and nea as much more from the bitumin

district. It is estimated that these waters and the discharge from the washeries carry more than 3,000 tons per day of free sulphuric acid and acid salts. In this state 96 public water works, supplying nearly 45 per cent of the total population, are affected. The estimated cost to the state of such pollution is more than eight million dollars annually. At McKeesport, Pa., the Youghiogheny River, formerly used for water supply after filtration and softening, became polluted to such an extent as to neecssitate a change in the source of supply. The acidity of the river water was at times as high as 390 parts per million. The Pennsylvania Department of Health reports other cases in the state where a change of supply has been made necessary on account of heavy acid pollution.

In West Virginia, the Department of Health reports 10 water supplies affected by acid mine drainage.

Unneutralized acid mine drainage, although tending to reduce bacteria by disinfection, affects the appearance of the stream, destroys fish life, causes corrosion of pumps, distribution systems and house plumbing and entails extra expense for treatment. One great difficulty is that old and abandoned coal mines continue to yield acid drainage for years, due to the extraction of sulphur by water flowing through gob piles both within and without the mines.

Neutralization of mine drainage with lime, followed by filtration, has been found effective at some places but the resulting sulphate of lime may assume such proportions as to affect prejudically the water for steam raising purposes. Softening by soda ash is sometimes resorted to, but is expensive and has certain limitations in practice.

Mountain Water Supply Co. vs. Melcroft Coal Co.—On Dec. 26, 1922, Judge Van Swearingen of the Common Pleas Court of Fayette County, Pennsylvania, handed down an opinion and decree refusing an injunction sought by the Mountain Water Supply Co., a subsidiary of the Pennsylvania Railroad, to restrain coal companies operating in Indian Creek Valley above the reservoir of the water company from permitting mine water to flow into the Indian Creek or its tributaries. The litigation began in 1920 when the plaintiffs filed a bill in equity against the Melcroft Coal Co., and it is of great importance in relation to the pollution of streams by acid wastes resulting from coal mining operations. Some of the basic elements of the case are taken from the extensive opinion of the court, embracing some 98 typewritten pages, as follows:

1. Indian Creek has a drainage area of about 130 square miles. Its head waters are in Westmoreland County and it flows in a southwesterly direction across Fayette County, entering the Youghiogheny River about ten miles above the city of Connellsville. Up to ten or fifteen years ago this watershed was of rural character, occupied by a population of about 2,500, who were largely engaged in farming operations and who operated a few small country mines for local use. The waters of Indian Creek were then fairly pure and well adapted for domestic use and steam-raising purposes.

2. About sixteen years ago the water company built a storage reservoir holding 251 mg. and also about 141 miles of pipe lines for distributing this water along the branch lines of the Pennsylvania Railroad extending as far west as Pittsburgh. The dry weather flow of this stream is nominally rated at 6.5 million gallons daily, but, with the aid of storage, something like 10 million gallons daily have been delivered to the railroad and to the Westmoreland Water Co., for supplementing its limited supply for industrial and domestic consumers in the Greensburg district.

3. When the reservoir was built, it was known that the watershed was underlaid by seams of the lower productive measures of bituminous coal. The lower Kittanning seam ranges from about 36 to 58 in. in thickness and above the storage reservoir there are about 43,000 acres of this coal vein. Coal mining has been quite extensively developed with the aid of a railroad now extending well toward the headwaters. The tonnage of coal shipped by rail from this valley prior to 1914 approximated 15,800 tons in the aggregate, but later activities increased the output in 1918 to 181,000, in 1921 to 329.600 and during the first half of 1922 to 300,000 tons. The mined out area increased from about three acres in 1914 to about fifty acres in 1922. The population is now esti-

mated at from 6,000 to 6,500, mostly in villages near the stream.

4. The flow of mine water depends upon rainfall and other local conditions, but approximated 1,760 gal. daily per acre mined out. This flow diminishes somewhat after mining operations cease but the acid content due to sulphuric acid may continue high and even increase due to drainage passing through the bone coal and gob piles.

5. The reservoir water now needs filtration to make it suitable for domestic use and for some ten years the expected acidity of the mine water will not require neutralization and softening to a greater extent than is now practiced by many public water companies and municipalities.

6. After a period of ten years the construction of storage dams on the upper parts of Indian Creek or some of its tributaries may provide diluting water so that the water of the present reservoir may be handled by usual and customary methods of treatment to make it fit for domestic and industrial purposes.

7. In considering the remedial measures it was held that it is not feasible or practicable for any or all of the coal operators of this valley to treat the mine water at the mines and that such treatment would entail an unreasonable expenditure. Further, on account of practical and economical difficulties it is not feasible for the coal operators to carry mine water below the storage reservoir.

8. The court ruled that neutralization or softening or other treatment of the Indian Creek water by the water company if, when and as necessary, will not entail an unreasonable burden on the plaintiff water company.

This decision is in line with the Sanderson case (113 Pa. 126) decided nearly 40 years ago in favor of a coal company as against a lower riparian owner through whose estate flowed a brook which was fouled by coal mine drainage and the water made unsuitable for domestic purposes. In the Melcroft case, the court balanced equities under local conditions where the coal mine operators were held to be pursuing a proper and natural use of their lands, with cost of remedial measures approaching property confiscation and where the Mountain Water Supply Co. was held to have no power of eminent domain and with the Westmoreland Water Co. viewed as nothing more than a purchaser of water from the Mountain Water Supply Co. The state Department of Health of Pennsylvania has no jurisdiction in respect to coal mine drainage or discharges from tanneries. This litigation related therefore to common law and not to statutory proceedings.

Gas and By-product Coke Wastes.—The great increase in the coal distillation industry has had a marked and widespread effect on water supplies, by imparting disagreeable tastes and odors to the water, particularly after chlorination. The state Boards of Health of Indiana, Illinois, New York, Ohio, Pennsylvania, West Virginia and Wisconsin report altogether some 50 water supplies affected in this way. The industrial plants giving rise to this kind of pollution are gas works, producer gas plants, by-product coke ovens and manufacturies receiving the products of these plants and extracting chemicals by further distillation and separating processes. The objectionable wastes come very largely from the tar saparators, ammonia, benzol and naphthalene stills, together with the residues and sludges from various parts of the plant.

It is becoming generally recognized that the odor and taste from these "creosotes" or "phenols" is greatly accentuated by chlorination of the water supply due to formation of chlorphenols or other substitution products.

The tastes produced have been variously described as "chemical," "creosote," "hospital," "medicinal," "carbolic acid," or "iodoform." Persistence of the taste in dilution as great as 1 part of waste to 10 million parts of water or after passage by stream as far as 70 miles has been reliably reported.

At Milwaukee obnoxious tastes in the chlorinated water supply were shown to be due to coal tar derivatives discharged from coke and phenol plants directly or indirectly into Lake Michigan from which the city takes its water supply. Tastes in the chlorinated water were reported in dilutions of one part of phenol to 500 million parts of water.

Pollution by coal distillation wastes

have been studied in several states of the middle west and along the Atlantic coast in the last few years.

An extended series of tests to determine the cause of tastes and odors in the Cleveland water supply led to the conclusion that they were due principally to the waste liquors from ammonia stills of by-product coke oven plants.

An extensive joint investigation has recently been made by the city of Chicago and the Chicago Sanitary District to determine the effect of pollution, including coal tar wastes, entering the Calumet River and Lake Michigan upon the quality of the water supply taken from the 68th Street and Dunne cribs. The conclusion reached was that the probable concentration of polluting material, reaching the two cribs, was insufficient to cause taste in the supply. In Appendix IV of the report of the Chief Engineer of the Chicago Sanitary District, are given results of tests to determine the lowest dilutions of various phenol wastes required to give taste with chlorinated unpolluted lake water. Wastes from gas and coke industries could be detected in dilutions of 1,000 to 100,000 volumes of lake water. The intensification of the tastes due to chlorine was found to be much less than reported by observers in other localities.

No satisfactory method for water purification has been found to eliminate the tastes and odors due to phenol wastes. At Youngstown, O., excess lime treatment is reported as being successful in reducing objectionable odors and tastes. At Newcastle, Pa., a considerable reduction of the phenol content of the raw water by the use of iron and lime as coagulant in connection with filtration has been reported.

For taking care of the wastes at the source the West Virginia Department of Health reports success in one case by pooling in porous ground.

The Pennsylvania Department of Health has been obliged to take measures to prevent entry of such industrial wastes in the streams above the water supply intake. A practical and effective remedy in some cases has been found in the evaporation of the objectionable wastes from by-product coke plants by using them for quenching the glowing coke. In one case the residual wastes from a water gas plant remaining after re-circulation of the settling basin effluent through the gas scrubbers were treated with ferrous-sulphate and filtered through coke breeze, after which it is used for boiler water.

Plants suggested in Wisconsin for the treatment of gas house wastes have been described by E. J. Tulley. They comprise retention units for separation of tar and light oil, aeration, chemical treatment with lime or copper and lime, sedimentation and double filtration through coke contact beds and gravel sand filters. No information is available as to the practical workings of this process.

In connection with the activated sludge process of sewage treatment at Milwaukee, Mr. Copeland has found (7th annual report of the Sewage Commission, 1920) that the activated sludge process was able to handle sewage containing considerable amounts of phenol and that the process removed a substantial portion of them. The results of these tests indicate that the activated sludge plant now being constructed in Milwaukee will materially protect the lake water supply from tastes produced by phenol discharge into the city sewers.

Wood Distillation Wastes.—Plants employing the destructive distillation of wood for the recovery of wood alcohol, acetate of lime, creosote oils and charcoal are reported as affecting water supplies in a number of the states and in the Province of Quebec.

Troublesome wastes consist of the spent still liquors, residues from the stills and certain sludges and crude tars. These wastes impart a pronounced "smoky" taste and characteristic "creosote" ordor. Unlike the coal tar phenols, the taste and odor from the wood distillation wastes appear to be intensified little by chlorination.

The Wisconsin Department of Health reports tastes and odors from wood distillation plants to have occurred mainly during the winter months when the lakes were frozen.

In Pennsylvania evaporation of the wastes, discharge into abandoned quarries or distribution on the ground surfaces at distances from the streams, are methods found effective according to the Department of Health.

At Marquette, Mich., the remedy

proposed was the evaporation of the most objectionable wastes to 25 per cent of their original volume and utilization of this residue as liquid fuel.

A disagreeable taste in the water supply of Elizabeth, N. J., was found to be due to creosote oils spilled around the building and washed into a brook contributing to the water supply. In this case chlorination was found to increase the taste materially, but aeration caused a marked reduction.

Aeration by means of fine spray nozzles is being tried at one Pennsylvania water plant for the elimination of tastes and odors due to wood distillation wastes, after experience had shown that ordinary aeration followed by filtration failed to eliminate the disagreeable qualities.

Corn Products Wastes.—One water supply in Indiana is reported as being polluted by wastes from gluten settlers at a corn products factory. These wastes affected the appearance of the raw water, caused a marked increase in bacterial growth and imparted an odor and taste. Increased amounts of chemicals were required in coagulation and the chlorine dose had to be raised. A testing station for the experimental treatment of corn products wastes is being operated by the Chicago Sanitary District at Argo, Ill., to determine the best method of treating such wastes.

Wastes From Manufacture of Dyes and Intermediates.—Two water supplies in New Jersey are reported to have been affected by the wastes from the manufacture of dyes and intermediates, the trouble manifesting itself in an objectionable taste in the water.

The New Jersey State Department of Health reports that, as the result of injunction proceedings brought to prevent the pollution of the Rahway River, the source of water supply for the city of Rahway, by wastes from the manufacture of dyes, the manufacturing concern is now treating the industrial wastes by the method of chemical precipitation with lime and copperas, followed by filtration through sand.

Wastes From Manufacture of Munitions.—The wastes from munitions plants are in much the same class as those from dye works. At Kenvil, N. J., the State Department of Health found that the "ether" and "chemical" tastes in the water from individual wells on the outskirts of the town were caused by wastes from a munitions plant taken in solution by storm water and gradually percolating into the underground stratum in which the wells are located. A new source of water supply will probably be necessary.

The New York State Department of Health reports one water supply affected by picric acid from a TNT plant. This imparted a yellow color to the water and produced very objectionable odors and tastes against which the ordinary purification facilities were ineffective.

The Superior Board of Health of the Province of Quebec reports one water supply affected by acid wastes from a powder works. The remedy consisted in neutralizing the acidity prior to the discharge of the wastes.

Leatherboard Wastes.—The Board of Health of New Hampshire reports one water supply affected by leatherboard wastes which clog the slow sand filter. The amount of suspended solids discharged into the stream has been greatly reduced in recent years by sedimentation.

Metal Pickling and Galvanizing Wastes.—Seven water supplies in Ohio are reported to be affected by metal pickling and galvanizing wastes. The objectionable substances consist of free acid and acid salts which affect the appearance of the raw water, and interfere with coagulation. Lime treatment and filtration have been found effective, although soda in addition would be required to offset the increased sulfate hardness resulting from neutralization.

Metallurgical Mining Wastes.—In the mining industry considerable ore is milled by the oil flotation process from which comes a very large volume of waste consisting mostly of finely pulverized rock. This material is usually ponded without difficulty, but one water supply in California is reported by the State Board of Health to have been affected. Increase of turbidity was the only objectionable effect in this instance.

In Colorado some of the most beautiful streams have been ruined by the tailings from mines against which pollution some court injunctions have been issued, as is true of the cyanide process for ore extraction where

ky tanks might drain into the urce of water supply.

In California the pollution of water pplies by the cyanide process has en occasionally alleged although not finitely established.

The California Board of Health rerts one case where the spent uors from the plant of a copper mpany appeared to have a benefiil effect by reason of its disinfectg action on the sewage contamited river used as a source of water pply.

Oil Wells—Crude Oil and Salt ater.—Crude oil spilled into water pplies affects appearance, odor and ste, interferes with coagulation, filation and chlorination. The slow nd filtration plant at Pittsburgh has en reported as troubled with parfins which encrust the sand grains d interfere with normal operation the filters.

By far the most serious effect on ater supplies of oil well operation that due to the discharge of salt ater from the wells with the oil. e salt wastes affect palatability of e water and limit the usefulness of e water for boiler use and indusial purposes. The trouble from salt llution is quite widespread and has en the subject of litigation in many ates and has resulted in more than e city changing its source of supply.

In Oklahoma not only the streams e reported to be generally affected t the ground water as well, by reaon of ineffectively plugged and abanned oil wells.

Oil Refinery Wastes.—Much trouble reported from Kansas and other l producing states on account of the aste waters from oil refineries hich sometimes affect the water pplies by causing very serious stes and odors. The Kansas State oard of Health reports many Kans supplies affected by the wash ater from the agitators in which ude gasoline and kerosene are purid. Independence, Missouri, is reorted to have been affected by oil finery wastes. Water supplies at e south end of Lake Michigan at ast Chicago and Whiting, have been milarly affected. Other cases of llution by oil refineries are reported om Pennsylvania, Texas and the rovince of Quebec.

Paper Pulp Mills.—Water supplies a number of states are reported as having trouble with wastes incident to manufacture of woodpulp. The wood fibre itself has caused some trouble, but the greatest damage done to the stream by mills of this character is due to the discharge of waste sulphite liquor which imparts a very high color, difficult to remove, even when greatly diluted. The presence of these wastes retard coagulation, call for a greatly increased dose of coagulant and of chlorine required to sterilize. Aeration after coagulation and sedimentation has been of value, in at least one instance, in treatment of a water supply contaminated with sulphite waste. Disagreeable tastes and odors are caused by sulphite wastes, if present in appreciable quantities.

Sawdust.—The State Department of Health of New Hampshire reports that in a few instances the operation of saw mills has affected water supplies by imparting color.

The State Board of Health of Oregon reports that chlorination plants, located in small cities, have been affected by sawdust discharged from sawmills on the streams used for water supply.

Tannery Wastes.—Replies to the questionnaire show one supply in New York, two in Pennsylvania and four in West Virginia affected by tannery wastes. This number is probably far short of the number of supplies more or less affected. Tannery wastes contain much organic matter and markedly increase the color and in some cases the turbidity and bacterial content of the supply.

Treatment of these wastes at the source has been partially successful in West Virginia where lagooning is used. Tannery wastes are susceptible to treatment by sewage purification processes. There are a number of such treatment plants in Massachusetts where well purified effluents are produced.

Studies made by the United States Public Service and published in Bulletin 100 indicate that tannery wastes may be treated so that the effluent will not unduly affect water purification plants provided the same factors of time and dilution are allowed as considered necessary in dealing with a water supply containing sewage. Consideration must be given to possible danger from anthrax germs when dealing with tannery wastes.

Textile Wastes.—Spent dye liquors, scouring and washing wastes and bleach liquors are the substances reported as most troublesome from textile industry. These wastes affect the appearance and oxygen demand of the stream and have been the cause of tastes in water supplies.

Solution for Water Supply Problems Due to Industrial Wastes.—There are three general methods of attacking problems of water supply resulting from the discharge of industrial wastes.

1. Treatment of the polluted water.
2. Treatment of industrial wastes prior to discharge.
3. Elimination of industrial wastes from the source of water supply.

There are some kinds of industrial waste which may be handled by water purification plants without serious overload or impairment of the quality of purified water. In other cases, the pollution may be of such nature and of such amount as to necessitate special treatment at the water purification plant with closer supervision and increased operating cost. There are some wastes, however, which are of such obnoxious character that ordinary purification plants are not able to handle them successfully. Feasibility of recovery of valuable by-products from industrial wastes must not be overlooked.

Preventive measures are needed to control the discharge of industrial wastes into existing or potential sources of water supply. Due regard must be had for established industries and arbitrary and unreasonable measures should not be used against them. The problem must be considered from the broad viewpoint of public welfare.

When these problems are confined to a single state the control should be placed in the hands of State Boards of Health and new laws and modification of existing laws should be enacted wherever necessary to enable these boards to control effectively the situation. Adequate appropriations for field and laboratory investigations are essential. The policy of many states must be broadened in these respects in order properly to protect the public interests. Investigation should precede legislation and drastic action should be employed only when found necessary.

In the case of interstate problems of this kind the Federal government should not be overlooked. The Unit States Public Health Service has ready made extensive investigatio along this line and should be fortifi with adequate legislation and appr priation to carry out the work alrea started.

A study of existing and need legislation, local, state and feder relating to the pollution of wat supplies by industrial wastes, has been completed by your committe Attention is called to an excelle digest of judicial decisions and a co pilation of legislation relating to t subject of stream pollution prepar by Montgomery and Phelps, and pu lished by the United States Publ Health Service as Bulletin No. 87 November, 1917.

While it is important to set wisely drawn statutes and to arm ce tral health boards with reasonab authority, it is not to be overlook that large industries frequently reso to the courts and thus defer for long time a final settlement of t problems of industrial wastes di posal. The latter have their econom aspects and in Europe such proble were not much advanced until Distri Drainage Boards or River Conser ancy Boards were established bringing about coordinated cooper tive effort so that all concerned cou proceed with a unified progressi policy and working program. Owne of industrial plants are given repr sentation on these boards and as it largely their money which is to spent for treatment of these waste it is no more than fair that th should have a voice in remedying types of pollution in a given valley locality.

Small Irrigation Projects in Ca ada.—The construction of small ind vidual projects is interesting mar farmers in Canada whose lands ca be irrigated by direct diversion fro nearby streams in the semi-arid are and the waters of some of the streams have been practically all a propriated. Some of these sma projects have been operated succes fully for many years and there we in 1921 483 licensed or authoriz schemes, while applications for 2 new schemes were recorded in 192 making a total of 711 small projec in operation or under construction u der the supervision of the Canadia Reclamation Service.

Railways

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.

221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*

LEWIS S. LOUER, *Vice-President and General Manager*

New York Office: 904 Longacre Bldg., 42d St. and Broadway

RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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ol. LX. CHICAGO, ILL., AUGUST 15, 1923 No. 2

Relieved

Upon recommendation of the utili-s and finance committees of the City uncil the Seattle Municipal Railway s been relieved of the requirement at it pay for paving between its acks. In September, 1921 it was re-ved of jitney bus competition by islation ruling jitneys off the eets. As a minor measure of relief, e rides for police and firemen were olished when the City acquired the es in 1919. Increased fares have en established to relieve the finan-l burdens of the system. But in ite of these measures Seattle has not t found a way to pay operating ex-nses and capital charges on its rail-ys.

Seattle has learned two lessons from ese and correlative facts although as t she is unable to profit from them. e first lesson is that municipal oper-ion of this class of utilities is a dif-ult and dangerous undertaking; and e second is that from their own andpoint and on as selfish a basis as any cynic may choose to state, the citizens would profit by fair treatment of the privately owned utilities that serve them. We use "fair treatment" in its exact sense and with no inferential meaning of special favors or public largesse to the utility companies.

If Seattle had granted to the private owners of the lines prior to 1919 even a part of the relief that has been granted to the municipally owned and operated system, those owners would have rendered the same service that is now being rendered while the City would have been saved many hundreds of thousands of dollars in operating losses accrued to date, and would have had the benefit of the annual taxes on the property. In addition the owners would have had the incentive to progress and development which follows knowledge of a reasonable opportunity for financial success —an opportunity which had been absent for years prior to the transfer of the property.

There were, we believe, two principal reasons for the failure of the

City to grant to the company the relief which it needed in order best to perform its functions. The first of these was a disbelief in the company's statements that it could not prosper or render thoroughly good service under conditions as they existed. The experience with public ownership has gone far to convince Seattle citizens that they were wrong in this regard. The second reason was a meanness of spirit which said in effect: "We are not concerned with the Company's prosperity: we'll take everything we can get out of it." This attitude is maintained by an unfortunately large number of people—not alone toward the public utilities but in almost every relation of their lines. Such people are not a majority but they are often stubborn.

The paving requirement, which is generally in effect throughout the country, is a relic of the days of horse cars, inaugurated on account of the concentrated wear incident to that system. Its continuance under electric traction follows merely from custom, and results in the company's paying for an installation chiefly for the benefit of others. The maintenance of the strips of pavement next the rails is another matter. The requirement for the paving of all track between rails has no basis of logic under present conditions. If the company owes anything to the City, it were better that it be paid in cash or adjusted through reductions in fare. Few people who have not studied these problems have any conception of the huge investments—both absolute and proportional—which the street railways of the country have made in pavements.

Whatever one's personal views may be as to the advisability of prohibiting jitneys the fact is that in Seattle the street car company was compelled to accept their competition, while the City lines were relieved from it. It may be that few of our cities can maintain the two quite different classes of transportation furnished by the street cars and the jitney buses.

Fare changes under municipal ownership have been numerous and radical, and demonstrate clearly that increased travel under a 5 cent fare is far from sufficient to compensate for a reduction from 10 cents. The company's fare when it sold out to the City and for some time before was 5 cents. Within a year the fare was raised to 10 cents cash or 6¼ cents token. In March of this year it was made 5 cents cash, and in June it was raised to 10 cents cash or 8 1-3 cents token.

The City of Seattle took over its railways because it was dissatisfied, and thought it could do better with them than could the company. The company sold because it could do no better than to sell. The $15,000,000 in 5 per cent bonds issued by the City in payment approximated the original cost of the lines but owing to the increase in the price levels of labor and materials was less than cost of reproduction minus depreciation. In other words the City could not have installed a competing system anywhere nearly as economically as it secured the old system. The interest rate is less than a private company would have to pay but even with this and the various "reliefs" the City failed to do as well with its plant as the private company had done. If Seattle had granted merely a fair chance to her street railway company she would today be the gainer in everything but experience.

Possibilities of Increased Serviceable Time With Electric Locomotives

Editorial in Railway Review, August 4

Have the advocates of railway electrification overlooked their hand in failing to emphasize the higher percentage of serviceable time which it is possible to obtain from electric motive power than is ordinarily developed by steam locomotives? If electric locomotives can be operated for an average of 16 hours per day as compared with the 8 serviceable hours produced by the average steam locomotive, this would have a material bearing upon the size of the investment that the railways could afford to place in electric equipment in order to realize the direct operating savings accruing from electrification. With the elimination of fire building, fire dumping, boiler washing and other routine operations as well as the current repairs incident to steam locomotive operation it would seem possible to keep the electric locomotive on the road many more hours per day. This, in a measure, has been accomplished on the New Haven as described by the electrical engineer of that system

n an article for the Railway Review f January 6. On the New York Cenrol, however, it is understood that he electric locomotives handling assenger trains between the Grand entral Terminal and Harmon, a disance of 33 miles, do not average uch over 3500 miles per month. his undoubtedly is on account of the hort run and frequent terminal layvers. Coming now to a system on hich electric locomotives are emloyed on long freight runs, it is ound that the electric locomotives in reight service do not average more han nine serviceable hours per day or the entire year as contrasted with n average of seven hours per day or the steam locomotives in freight ervice on the same railway. As the aily serviceable hours for the elecric locomotives averages as high as leven and one-half hours for some nonths and it has been found entirely ractical to hold these locomotives in ctive service for 48 hours at a time is probable that the manner in hich these locomotives are operated ather than the physical limitations f this class of power is primarily esponsible for failure to produce a igher percentage of serviceable ours. The density and irregularity f traffic movement together with the ecessity for equalizing the current equirements and utilizing this curent so as to obtain it at the lowest verage cost are conditions that may urther tend to curtail electric locootive output. These observations on he performance of electric locootives further suggest the thought hat the output of steam locomotives, easured in serviceable hours, is eing limited more by conventional mitations in the method of their peration than by inherent limitations this type of motive power. Unoubtedly, the most severe physical mitation to increased steam locootive output is to be found in inlequate terminal facilities. Possibly he electrical engineers have believed hat in this respect, electric motive ower possessed no fundamental adantage over the steam locomotive, iven adequate terminals and assumg progressive operating methods.

Ten Crossing Tragedies on One Sunday

Editorial in Railway Age for August 4

Requiring every automobile driver to bring his car to a stop before crossing a railroad track is, admittedly, a crude regulation; and, as in the case of all crude regulations embodied in statutes, enforcement is attended by varied difficulties. Already the Federal Bureau of Public Roads calls attention to the fact that laws like those of Virginia, Tennessee and North Carolina, fit some situations very badly; as, for example a crossing where the number of railroad trains is perhaps two a day, while the automobiles on the highway are numbered by the hundreds. It is reported that the bureau disapproves of state legislation like that in the states named; the railroad trains ought to be stopped instead of the automobiles. There are, of course, cases where this would be the proper remedy. But, as was suggested in our note on this subject on July 28, the present need is agitation. It is probable that vigorous action looking to enforcement of the present laws will be the best way to secure such modification as may be found feasible and desirable. Changing the statutes is slow business. Whatever the deficiencies of the statute, every driver is bound, under the common law, to observe the rule at places where it is necessary and reasonable, even if there be a hundred cases where a jury would exonerate him in case he disobeyed it. The trouble is that so large a number (though perhaps a small percentage of all drivers) prefer to have no law at all. These must be awakened, in some way, unless all trains are to be brought down to 10 miles an hour. The present slaughtering cannot go on indefinitely. The number killed in automobiles on crossings in the United States last Sunday was thirty-six, as noted in another column. Every responsible public officer in each of the nine states reporting these tragedies is bound to take cognizance of the whole list. Moreover, railroad officers, as the best informed citizens, have a serious duty as agitators. Our legislators are, as yet, only half awake.

Current Material Prices

Iron and Steel Prices

(From the Iron Age, Aug. 2, 1923)

Prices as of July 31, f. o. b. Pittsburgh:

Open hearth rails, heavy, per gross, ton	$43.00
Light rails (25-45 lb. section), per 100 lb.	2.25
Track spikes, 9/16 in. and larger base, per 100 lb.	3.15
Track spikes, ½ in., 7/16 in. and ⅜ in., 100 lb.	$3.50 to 3.75
Track spikes, 5/16 in.	3.50 to 3.75
Spikes, boat and barge, base, per 100 lb.	$3.50 to 3.75
Track bolts, ¾ in. and larger, base, per 100 lb.	$4.00 to 4.25
Track bolts, ½ in. and ⅝ in., base, per 100 lb.	$5.00 to 5.50
Tie plates, per 100 lb.	2.55 to 2.60
Angle bars, base, per lb.	2.75

Finished Iron and Steel

	Per lb. to large buyers. Cents
Iron bars, Philadelphia	2.67
Iron bars, Chicago	2.50
Steel bars, Pittsburgh	2.40
Steel bars, Chicago	2.60
Steel bars, New York	2.74
Tank plates, Pittsburgh	2.50
Tank plates, Chicago	2.80
Tank plates, New York	2.84
Beams, Pittsburgh	2.50
Beams, Chicago	2.70
Beams, New York	2.84
Steel hoops, Pittsburgh	3.15

Freight Rates

All rail freight rates from Pittsburgh on domestic shipments of finished iron and steel products, in carload lots, to points named, per 100 lb., are as follows:

Philadelphia	$0.32
Baltimore	0.31
New York	0.34
Boston	0.365
Buffalo	0.265
Cleveland	0.215
Cleveland, Youngstown, comb.	0.19
Detroit	0.29
Cincinnati	0.29
Indianapolis	0.31
Chicago	0.34
St. Louis	0.43
Kansas City	0.735
Kansas City (pipe)	0.705
St. Paul	0.60
Omaha	0.735
Omaha (pipe)	0.705
Denver	1.27
Denver (pipe)	1.215
Pacific Coast	1.34
Pacific Coast, ship plates	1.20
Birmingham	0.58
Memphis	0.56
Jacksonville, all rail	0.70
Jacksonville, rail and water	0.415
New Orleans	0.67

Rails and Track Supplies at Chicago

Standard Bessemer and open-hearth rails, $43; light rails, rolled steel, 2.25c, f. o. b. makers' mills.

Standard railroad spikes, 3.25c mill track bolts with square nuts, 4.25c mill; iron tie plates, 2.85c steel tie plates, 2.60c, f. o. b. mill; angle bars, 2.75c, f. o. b. mill.

Jobbers quote standard spikes out of warehouse at 3.90c base and track bolts, 4.90c base.

Cement Prices

Recent quotations, per bbl., in carload lots, exclusive of package:

Pittsburgh	$2.24
Cincinnati	2.54
Detroit	2.50
Chicago	2.20
Milwaukee	2.37
Duluth	2.20
Minneapolis	2.50
Davenport, Ia.	2.43

Cross Tie and Lumber Prices

(From Lumber, Aug. 3, 1923)

White Oak Ties

F. o. b. cars, Chicago, Aug. 1.

No. 5—7x9x8	$1.85
No. 3—6x8x8	1.55
No. 1—6x6x8	1.35
No. 4—7x8x8	1.75
No. 2—6x7x8	1.45

Red oak ties, 10@15c less than white oak. Sap pine and sap cypress, 10c less than red oak.

White oak switch-ties, per M. ft.	$55 to $58
Red Oak switch-ties, per M. ft.	49 to 51

White Oak Ties

F. o. b. cars, St. Louis, Aug. 1.

No. 5—7x9x8	$1.50
No. 4—7x8x8	1.37
No. 3—6x8x8	1.25
No. 2—6x7x8	1.15
No. 1—6x6x8	1.05

Red oak ties, 10c per tie less than white oak prices. Heart pine and heart cypress, same prices as red oak. Sap pine and sap cypress, 25c less than white oak.

White oak switch ties, per M. ft.	$48.00
Red oak switch ties, per M. ft.	45.00

Bridge and crossing plank, same prices as switch ties.

Market Prices of Lumber

	Flooring, 1x4, No. 1 common	2x4, 16 ft., No. 1 common	Timbers, 6x6	Timbers, 12x12
Boston—Yel. Pine	.....	.....	$55@57.00	$63.00@66.00
New York—Yel. Pine	$52.00	$45.75	50@52.00	59.00@66.50
Buffalo—Yel. Pine	56.00	.....	.....	47.50@51.50
Chicago—Yel. Pine	49.00	35.00	.....	47.00@56.00
St. Louis—Yel. Pine	45.50	32.50	.....	41.50@42.50
Seattle, Wash.—D. Fir	56.00	20.50	28.00	25.00

Southern Mill Prices

	Flooring, 1x4, No. 1 flat	2x4, 16 ft., No. 1	Timbers, No. 1, 4x4 to 8x8	Timbers, No. 1, 3x12 to 12x12
Alexandria—So. Pine	$39.50	$27.50	.....	.....
Birmingham—So. Pine	41.05	27.00	.....	.....
Hattiesburg—So. Pine	40.82	26.52	.....	.....
Kansas City—So. Pine	.....	27.34	$30.65	$45.30

The Chicago Union Station Development

Paper Presented July 12 at 53rd Annual Convention of Am. Soc. C. E.

By J. D'ESPOSITO
Chief Engineer, Chicago Union Station

The general principles governing the ocation, design and construction of a nodern passenger terminal are today 'or all practical purposes the common property of the engineering profes-ion. It is true that there is no uni-ersal agreement among engineers on ll matters involved in the creation of a large, modern passenger terminal, but nevertheless, the fact remains that most of the recently built great terminals show a uniformity of con-ception and arrangement which bids air to become a fixed type.

The claim is not made that the new Chicago Union Station is a radical leparture from the accepted idea of a modern passenger terminal of its ype, nevertheless it is felt that this newest of stations, in the negotiations eading to its development, in the provisions made to meet its peculiar equirements, in the arrangement of a combined station and office building, and in the solution of the mail han-iling problem, possesses many charac-teristics which invest the subject with distinctive interest.

Features, Requirements and Limita-tions.—The Chicago Union Station had to be co-ordinated with and worked into a scheme of a city beau-tiful plan; it involved real estate transactions of the most complex na-ture; it necessitated the creation of new freight terminals for several railroads; it furnished the opportu-nity for the building of the first large railway mail terminal building in the United States and made possible a station layout which, while placed below the general street level, owing to the limitations imposed by the site, is a one-level station in the full mean-ing of the word; that is, one in which the users find all the facilities of the station on one floor, and that the track level floor.

General View of Station.
Train Sheds in Foreground Across River: Head House and Main Building at Back Left; Proposed Government Building in Center Existing Chicago & Northwestern Station at Right.

The present station was built in 1880, at which time Chicago had a population of 500,000 people. The population of Chicago today is 3,000,-000 and the railroads entering the station have grown to a correspond-ing extent.

Coordination With City Plan.—The earliest scheme contemplating the re-building of the station dates back to 1901, at which time less thought was being given to co-ordinating a passen-ger terminal with plans of city devel-opment than is being given to such

matters today. The plan which was eventually adopted for the new Chicago Union Station was laid out in the year 1906, and as a matter of course did not coincide with the conception of railroad terminal arrangement and location as set forth by civic bodies and other well meaning persons who had endeavored to solve the Chicago railway terminal problem. The railroads interested in the proposed improvement, having reached an agreement upon the major elements involved in readjusting the facilities absorbed by the proposed rearrangement, in the spring of 1913 applied to the council of the City of Chicago for an ordinance covering every phase of the proposed improvement.

At that time three suggested solutions of the Chicago Terminal problem were prominently in the public's eye. First, the so-called Delano scheme, which located all passenger terminals south of 12th Street, now Roosevelt Road; second, the Chicago Beautiful Plan scheme, which located a number of terminals west of the River above the street level in the block between Canal Street and Clinton Street, and the third scheme, fathered by the Architect Jarvis Hunt, which proposed a single huge terminal for all the railroads entering Chicago to be located between State Street and the River, extending from Harrison Street to 12th Street.

Numerous suggestions were made by many others having various ends in view, but the three solutions above mentioned were the only ones which had any elements of practicability and carried weight, by reason of their sponsors as well as through the advertising given to the projects by the local press for a long period of time. The Union Station Company's project did not happen to coincide with any of the solutions above mentioned, and it became necessary to find some means of convincing the city as to the soundness of the railroad project, making such secondary changes as the demands of the situation required and the needs of the railroads would permit.

The Problem of Relocating Freight Terminals.—One of the most important and most complex elements of the problem was necessity of having to provide new freight terminals for the Pennsylvania Railroad, the Chicago & Alton Railroad and the C. B. & Q. railroad, in order to make possible the construction of the proposed passenger terminal. Of the three problems, that of the Pennsylvania freight terminals was the most difficult for the reason that the proposed passenger station layout absorbed every foot of space occupied by the old Pennsylvania freight facilities. In the case of the Alton road, the problem, while not so large in magnitude, was equally difficult, the Union Station layout absorbing over 50 per cent of the area of the Alton's freight terminal, and in order to make good this loss it was necessary to purchase all the land adjacent to its tracks east of Canal Street between Harrison Street and 16th Street, and on this land it was possible to rebuild freight terminals adequate for its needs.

The Pennsylvania railroad at an early stage in the negotiations reached the decision to relocate its freight terminal in a district which up to that time had been free of railroad encroachment, namely the area between Van Buren and Polk Streets, Jefferson Street and Desplaines Street, being approximately 300 ft. in width and 1600 ft. in length, and containing about half a million square feet. All of this land, which was made up of hundreds of individual parcels, was quietly purchased before the scheme was presented to the city for enabling legislation, and it was around this portion of the project that the storm of disapproval broke loose and threatened to wreck the entire scheme. It was found, for instance, that the Pennsylvania freight house would interfere with a proposed east and west street on a line of the present Congress Street as laid out in the Chicago Beautiful Plan, and it was also maintained that it would be unwise to permit railroad encroachment on a district which heretofore had been free of such detraction.

Special Investigations and Reports.—At about this time a body of public spirited citizens, members of the City Club, engaged Mr. Bion J. Arnold to investigate and report on the general scheme of terminal development for Chicago, having especially in view the proposed Union Station project and the relation of that project to an ideal solution; and simultaneously the City Council engaged the services of the late John F. Wallace for practically the same purpose.

The conclusions of Mr. Arnold's report were to the effect that the pro-

osed passenger terminal at Adams treet might better be located about ,200 ft. south, at Harrison street. Ir. Arnold rejected the Pennsylania's proposition for a freight terinal between Jefferson and Deslaines streets, his view being that o additional freight property need be cquired by the railroad companies est of Canal street and that such development would be detrimental the interests of the west side. He urther said that if an ordinance ere to be given to the Pennsylvania ailroad granting them the right to grouping all the stations south of Twelfth street, neither did he look with favor on the project of a single union station as proposed in the Hunt plan. In regard to the Pennsylvania freight terminal project, Mr. Wallace reported in favor of granting the necessary ordinance, but suggested that the approach tracks and the entire development be depressed in a manner similar to that suggested in Mr. Arnold's report. At this stage of the negotiations the operating officers of the Pennsylvania railroad decided not to accept the freight house ordi-

The Completed Postal Building.

uild a freight terminal in that localy, then the approach tracks and the reight terminal tracks should be laced below the general street level nd covered over so as to make them nobjectionable from every standoint.

The conclusions of Mr. Wallace ere in favor of granting to the railoads the right to build the station s contemplated, his solution for the eneral terminal problem being to loate all the remaining passenger terminals, other than those of the union station and the Northwestern in a station to be built at the lake front nd Twelfth street. Mr. Wallace reported adversely on the scheme of nance with the limitations imposed by the recommendation of the engineers' reports, and the whole subject of the union station improvement came to a standstill for the time being.

Following several months of more or less exasperating negotiation, it finally became possible to secure an ordinance authorizing the construction of a new passenger terminal, together with the necessary freight terminal, in the location and of a type as originally proposed by the railroads, with the exception that the original Pennsylvania freight terminal scheme was abandoned in its entirety and a new location substituted immediately west of the Chicago river

and south of Polk street, substantially as recommended in the reports of Messrs. Arnold and Wallace.

Losses Through Lack of Cooperation.—Looking at the matter in retrospect today, it is permissible to make a statement that a larger amount of cooperation at a very early stage in the negotiations between the railroads, civic bodies and the city would have simplified matters to a considerable extent and unquestionably would have saved considerable time and eventually considerable expense to all parties concerned. As it turned out, the year which was lost in the negotiations with the city in this one instance was sufficient to throw the beginning of the work into the war times, with a resulting increase in the cost of construction and labor difficulties, together with inevitable delay in the time of completion.

Provisions of the City Ordinance.—The Chicago Union Station ordinance was approved by the City Council on March 23, 1914, and accepted by the railroads on September 23, of the same year. Its principal provisions in the order of their importance can be classified as follows:

1.—The creation of a district bounded by the Chicago river on the east, Canal street on the west, Kinzie street on the north, and Twelfth street, now Roosevelt road, on the south, within which district the railroads operating in the new station have the right of readjusting their passenger and freight terminal in any manner not in conflict with the requirements and limitations set forth in the ordinance.

2.—The vacation of all the streets and alleys in the territory embraced by the limits above set forth, and the vacation of all the streets and alleys in an additional district bounded by the Chicago river, Canal street, Roosevelt road and Sixteenth street, giving to the railroads using the station the right of rearranging only their freight facilities in this second district.

3.—The railroads were granted the right to occupy the entire space under new viaducts to be built for all intersecting east and west streets, from the east line of Canal street to the river.

4.—Rights were granted to the railroads to remove from the district above named sewers and all other city improvements, so as to permit of the free and full use of the properties in question without interference.

On the other hand the railroads were obligated:

1.—To pay a certain sum of money as a compensation for street vacation and other grants made by the city ($2,686,558.92).

2.—To rebuild at their own expense all the viaducts within the area above noted of a type acceptable to the city, and perpetually to maintain them.

3.—To rebuild a sewer system outside of the district in such a way as to take care of the portion of the sewer system removed from the railroad properties.

4.—To widen and rebuild Canal street at a uniform grade all the way from Washington street to Roosevelt road, without any compensation from the city other than the cost of the air rights over the 20-ft. strip required for street widening.

It was agreed in the ordinance that the railroads should build two bridges over the Chicago river, one at Monroe street and another at Kinzie street, deducting the cost of such bridges from the money due to the city for street vacations.

Land Acquisition.—The district affected by this grant within the limits of which all the existing structures, streets and public facilities have been changed or are in the course of being changed is almost 100 acres in extent, 35 acres of which are required for the passenger terminal itself, the remainder being needed for the several freight terminals of the railroads, owners or tenants of the union station. Within this district thousands of individual parcels of land had to be secured, the most important being as follows:

Western Electric Co.'s plant, south of Polk street, 208,000 sq. ft.; Illinois Tunnel Co.'s plant, 223,000 sq. ft.; Corn Products Co., 227,000 sq. ft.; B. & O. C. T. Co., parcel of 313,000 sq. ft.; two large warehouses of Marshall Field & Co., north of Polk street, the Commonwealth Edison Co.'s power plant at Harrison street and the river; warehouses of the Anheuser-Busch Brewing Co., south of Harrison street, Butler Bros.' warehouse, north of Washington street.

Negotiations leading to the purchase of these properties were carried on simultaneously with the negotiations with the City of Chicago in regard to the ordinance, and in no case

s it necessary to resort to condemnation proceedings. In the case the purchase of the warehouse om Butler Bros. the owners preferred to have their compensation in e shape of a new warehouse to be ected by the Station company at its le cost and expense, in lieu of the rehouses taken over by it, which al resulted in the Station company dertaking and carrying out the ligation of building a warehouse of out 10,000,000 cu. ft., in accordance th plans and specifications previous- agreed upon between the Station mpany and the owners.

The Scheme As It Stood in 1914.—e scheme of station improvement contemplated at that time consisted the following units:

(a) A low monumental building st of Canal street, containing a neral waiting room, ticket office, ich rooms, rest rooms, and other ated facilities.

(b) A concourse and train sheds st of Canal street.

(c) Two groups of stub tracks, 14 the south end of the station and 11 the north end, each pair of tracks ng served by a common platform, s platform to be used by passenrs and for baggage, mail and exess trucking.

(d) A baggageroom placed below concourse with a system of tunls reaching the outer end of all tforms, with elevators at both ends the platforms for lifting trucks d handling baggage, mail and exess.

(e) A large express building locat- east of the southern group of cks in the approximate location of e present Railway Mail building.

(f) A mail unloading platform ng the river between Jackson levard and Adams street, at the st end of the concourse.

The Scheme As Changed.—The ns which are now being carried depart from the original scheme the following particulars:

1.—The low monumental type of ilding west of Canal street has en changed to a combined station d office building 29 stories high, oviding all told over 500,000 sq. ft. office space.

2.—The large express building, inased to twice its original size and odified to meet additional requireents, has now become the Railway Mail building, the upper stories being leased to the government for the classification of parcel post matter.

3.—In addition to passenger platforms, separate platforms for handling baggage, mail and express have been provided, alternating with the passenger platforms.

After the introduction of parcel post service in 1917 it was obvious that the facilities as originally provided in the basement would prove inadequate to meet the changed conditions. The Federal government was giving serious study to the entire mail situation in Chicago, and the Postmaster General in 1919 appointed a committee of the Railway Mail Service, with Mr. William I. Denning, then superintendent of the Railway Mail Service, as chairman, to investigate and report on additional facilities and methods of operation. This committee reached the conclusion that a site conveniently located for both railway mail cars and motor trucks should be secured and a building of adequate dimensions to handle the mails erected, a very intensive application of mechanical handling apparatus being recommended to reduce operating costs. Protracted negotiations between the Railway Mail Service and the Union Station Company culminated in an agreement in December, 1920, whereby the Station company should erect a new mail building and lease the six stories above track level to the Federal government, the Station company retaining the track level story and basement for its own operations.

The site formerly proposed to be used for an express building, between Harrison and Van Buren streets, and just east of the proposed station tracks, met all the requirements of the government as to accessibility of railroad tracks and the affording of tailboard space for motor trucks, and it was on this site that the building was erected. The Union Station company's agreement with the government provided for the building being erected and put in service by Dec. 16, 1922, and on December 1 of that year the Station company had completed construction and the government proceeded to take possession.

The building is 796 ft. 5 in. long and 75 ft. 6 in. wide. Its total cubic content is 8,715,000 cu. ft. It is flanked on the east by a driveway 30 ft. wide. Its construction involved the

use of 7,500 tons of structural steel, 5,000,000 bricks and 32,000 cu. yds. of concrete. Approximately 3,000 tons of mail per day are being handled at the building, about 60 per cent thereof being handled by the railroads at the terminal as inbound and outbound mail. Outbound mail from other terminals is received at the north end of the tailboard space at driveway level and is deposited in chutes which deliver to track level or basement. This mail is then taken by tractors and trailers and raised to the tailboard space at the south end, whence it is dispatched to other terminals. Inbound mail destined to the postoffice in the upper floors in the building is taken direct by elevator to these floors. The intervening tailboard space between the north end (used for outbound mail) and the south end (used for inbound mail) is devoted to the requirements of the postoffice, all parcel post being received there. This mail is wheeled across the floor in small trucks to conveying belts which carry it to the third floor. On arriving at the third floor the mail is deposited on a feed belt from which it is taken off by sorters and placed on classification belts. The mail separated on the classification belts is transmitted through openings in the floor and over other belts to working tables on the second floor, and final separation and classification is made at these tables. Two inclined belts reaching the fourth floor also make primary classification similar to the belts reaching the third floor. After final classification, mail is dropped through chutes to belts below the ceilings which lead to spirals leading to track level. Over 8 miles of conveyor belts were used in the installation.

The building is equipped with nine 6-ft. 6-in. by 17-ft. and five 6-ft. 6-in. by 18-ft. freight elevators. Five hundred and eighty ft. of clear tailboard is available on driveway, or enough for 60 vehicles at one time. When all the tracks are completed there will be a car capacity of 61 postal cars. A tunnel running from the north end of the terminal to the basement of the concourse will afford connection with cars at the union station platform.

A noteworthy structural feature of the building is the 49-ft. 4½-in. steel truss weighing 365 tons, which carries the upper floor over a track entering the building at its west wall, at the south end.

The work of construction of th Chicago Union Station and its relate facilities was delayed by war condi tions and was entirely suspended o that account for over one year; i was interfered with by several strike the longest causing a nine month suspension of all construction activit in 1916-1917, and naturally was de layed again in 1921, when the dec sion was reached to change the orig inal scheme to one providing for a office building. It now seems pos sible to complete the entire project b the end of 1924, providing that th labor situation does not become mor acute than it is today and that w will be free from strikes or othe labor disturbances.

Portland Cement Production in First 5 Months of 1923

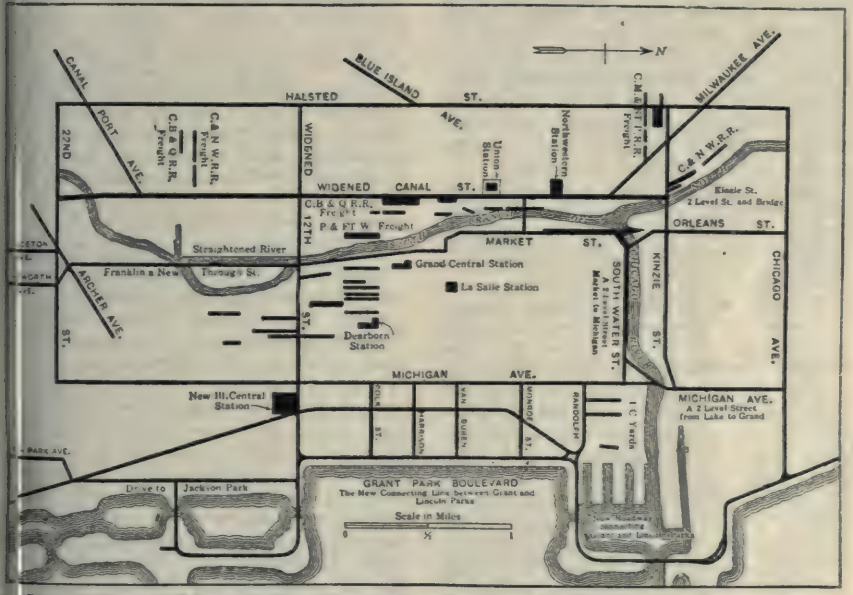
A report compiled by the U. S. Geological Survey shows that in the firs five months of 1923 a much large part of the year's requirements fo Portland cement in building and roa construction has been produced an shipped than in the same period o any previous year. Ordinarily thes are months of light demand but on ac count of increased building activit efforts have been made by the cemen manufacturers to spread the deman over the entire year in order to relie the peak load on this industry and t insure prompt delivery as well as a adequate supply. Both production an shipments of cement during the firs five months of this year exceeded a previous records for the same perio The increase over last year was mor than 40 per cent, for the period. Eac month also shows an increase ove last year in both production and shi ments. Shipments up to May 31st th year exceeded shipments in the sam period last year by upwards of 14 000,000 bbl. It is believed that a con siderable part of this excess repre sents shipments that otherwise woul be called for later in the year whe the demand is usually greater and de livery less certain on account of th increase in business activity generally Production of cement from Jan. 1 t May 31 this year was approximatel 50,000,000 bbl. as against approxi mately 35,600,000 bbl. produced in th same period in 1922. Shipment totalled approximately 48,900,000 bb as against about 34,600,000 bb shipped during the first five months o 1922, the best previous record.

Street Development and Railroad Terminals

The Relation of the Two Discussed in Paper Presented June 12 at 53rd Annual Convention of the American Society of Civil Engineers

By JACOB L. CRANE, Jr.
Municipal Development Engineer, Chicago

The problem of economical and convenient handling of railroad terminal business is made up of two elements, the transfer before reaching or after leaving the terminal, and the transfer within the terminal itself. It does not end at the door of the passenger terminal nor at the platform of the freight terminal. In fact, of the total cost in time and money, to deliver people or goods from their point of origin to a railway car, say, at least one-half must usually be assigned to that part of the journey over public streets before the portal of the terminal is reached. Moreover, the field for effecting future economies in the transfer of passengers and goods is more promising in the consideration of better facilities over the city streets than within the terminals themselves. Although these facts seem obvious, they have often not received the attention they deserve. This is true because, first, the railway terminals are planned by the railway companies and the streets by the municipalities, without adequate opportunity for them to work out together their joint problem of handling the terminal business. In late years, the latter difficulty is being overcome by the action of city plan commissions, railway terminal commissions, and joint committees, assigned to that particular problem. Such bodies are developing a definite technique of street planning in relation to railway terminals. It is this technique which the writer wishes to suggest, at least in some of its fundamental aspects.



General Plan of Chicago Railway Terminals as Developed by Chicago Plan Commission.

Requirements for Streets Serving Terminals.—In general, the requirements for streets intended to serve passenger terminals are somewhat different from those for freight terminals. These requirements will, therefore, be outlined separately. Street planning in relation to passenger terminals is concerned with the movement of passengers and baggage back and forth between a terminal and the

business and hotel section, the transit lines, and other terminals. The passengers and baggage are moved on foot, in taxicabs, private cars, trucks, and busses, and by transit lines. This movement over the streets should ideally be carried on with speed, safety and convenience, and at low cost, which means, first, direct routes, second, pavements adequately wide and properly graded and surfaced, and, finally convenient access and parking space at the terminals.

Street planning in relation to freight terminals is concerned with the movement of freight by truck and team between the terminal in question and industrial districts, warehouse and commercial districts, and other terminals. Separate routes are desirable for this slower moving traffic which requires a different type of street for its greatest convenience; heavier, rougher pavements, wider traffic lines, flatter grades, little or no provision for pedestrian movement, and specially designed loading and turning courts at the freight terminals.

Under each general heading there are special cases which involve special consideration, such as produce freight terminals, and exclusively suburban passenger terminals.

Volume of Traffic as Main Factor.—These fundamental requirements for streets to serve passenger and freight terminals are simple enough in their mere statement, but they are more difficult to meet in actual practice. And, as has been suggested, the main point of the whole topic is that most city street systems have developed without even an attempt to outline these simple fundamental requirements. Let us see if the volume of traffic created by the railroad terminals is sufficient to justify taking it into consideration as one among the main factors which must control the planning of city streets.

The total traffic load on the busiest streets of Chicago varies from 3,000 vehicles and 3,000 pedestrians to 30,000 vehicles and 30,000 pedestrians per day. These figures can be compared with the volume of traffic produced by typical terminals in this country. In Boston the North station handles about 25,000 through passengers and 70,000 suburban passengers each day, a total of 95,000; the South station handles a total of more than 125,000 persons daily. It is estimated that 1 per cent of the suburban passengers and 10 per cen of the through passengers leave th terminal in motor vehicles of one kin or another. Allowing two people t a motor car, this Boston terminal pa senger business develops upwards o 4,000 motor vehicle trips and mor than 240,000 pedestrian trips eac day.

This volume of business is th source of half of all the passeng and pedestrian traffic at certain poin in the most crowded streets of Bo ton, and is the cause of intolerab congestion outside the stations ther selves. When it is considered th the peak of this traffic load coincid with the rush hour load of other stre business, between 5 and 6 p. m., th importance of the terminal traffic even more striking.

Passenger, vehicle and pedestri traffic in volumes comparable to tho estimated for Boston are produced New York and Chicago, although th effect is less critical because of the somewhat more convenient street sy tems, and in Chicago, because the pa senger business is divided among s main stations instead of two.

Some Figures on Chicago Traffic.—Using the most recent available figur on Chicago package freight, it found that about 17,000 tons freight per working day are handl over team trucks, 7,000 tons are d livered by teams and trucks to ou bound freight houses, and 5,000 to are taken by teams and trucks fro inbound freight houses, a total 30,000 tons per day. This figure re resents at least 25,000 truck mov ments per day over city streets. A though there is no peak to this traf load to coincide with the rush hour it does continue through those hour and a large part of it does necessari move over streets already congeste by other traffic, and on those street by its own bulk and slow speed, offers the largest single obstructi to free traffic movement.

One-quarter of all the daily pa senger vehicle traffic on the Washin ton Boulevard bridge is made up the taxicabs going to and from th Chicago & Northwestern Statio More teams and trucks pass ov South Water Street in and out of th Illinois Central freight terminal in day than pass along any other stre in the city of Chicago. One-quart of all the pedestrian traffic in dow

wn Chicago flows to and from the ilroad terminals every day.

What the Designers Should Know fore Actually Planning Streets.—ese figures give an idea of the imrtance of terminal traffic in any reet planning project. They also ggest the fundamentals of street anning and development, namely, at such planning should be done for particular anticipated volume and aracter of traffic. Before actually anning streets, the designers should ve figures drawn up to indicate:

) The character of the various quotas of traffic for which the street is to be planned, distinguishing them as pedestrian and vehicular, commercial and pleasure, trucks and light vehicles.

) The volume of these quotas of traffic and the hourly and daily variation in the volume.

) The speed of the typical vehicles; which will depend less on the potential speed of the vehicle itself than upon the conditons of travel, such as crowding and character of pavement.

) The width, length and weight of the vehicles to be handled.

) The origin and destination of the vehicles and pedestrians.

) The nature of parking and loading space required, and the time for loading or waiting.

) Special factors such as traffic regulations, and, of course, projected rearrangements of streets.

In order to anticipate the volume d character of the traffic which a rtain street or system of streets is accommodate, a traffic census each ar for a series of years will indite the rate of increase in volume of affic and also tendencies in its changg character—the kind, size, speed d weight of vehicles. Automobile affic has been increasing at a rapidly d now it is possible to anticipate is increase up to the point of saturaon for an existing density of busiss and population. After that point saturation is reached, the problem comes one of anticipating the rate growth of business, industrial and sidential sections, and particularly e tendencies toward large movents in the location of these disicts.

Importance of Zoning Plans.—Zong plans are a great assistance in these studies. They show the prospective character and density of development in all parts of a city for a period of 20 to 40 years ahead, and usually in fact, for all time to come. If the same group that prepares the accelerating rate for the last 10 years, zoning plans also co-operates in working out the street plan, the most fundamental and authentic information will be available for anticipating the growth and tendencies in industrial and residential development. This information is also useful in planning the railroad terminals themselves as well as in planning the streets to serve the terminals.

Almost equally important to the anticpation of growth and development of the city are considerations of tendencies in terminal design. The projected intensive business development in buildings constructed over the electrified terminals in Chicago will produce an enormous volume of street traffic of different character and requirements from the terminal traffic proper. The tendency to consolidate terminals and to create general freight stations promises larger volumes of traffic from the sites of the enlarged plants, with a corresponding decrease from the abandoned sites, unless the latter may be developed for other uses.

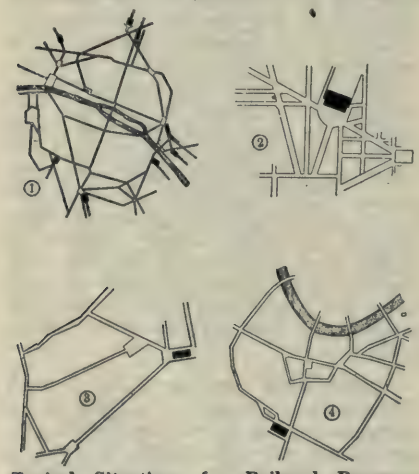
Traffic Load Decreased by Branch Terminals. — Branch terminals, through routing, extension of trap car, tunnel, or water transfer, all tend to decrease the traffic load on crowded streets and sometimes to distribute it on less crowded thoroughfares. In fact, this is one good reason for adopting these expedients where the development of terminals has exceeded the capacity of the street system to handle the traffic produced, and the improvement of the street system is impracticable or less economical than the expedients named.

The dominant conclusion of all these considerations is that the street system and terminal should be worked out together. The common sense necessity of this plan of procedure is further reinforced when the topic of grade crossing elimination is suggested. No program of making safer streets by eliminating grade crossings can be conceived without involving the whole question of terminal location.

Considerations from Architectural Standpoint.—There is also an im-

portant consideration from the architectural standpoint. The newer railway terminals of North America are easily the handsomest in the world. Their settings, however, are almost without exception so inadequate that the fine architecture is largely wasted because it cannot be seen. The ideal situation for a fine terminal building seems to be on a large plaza opening off special streets which in turn connect with main thoroughfares, and in each case located in full view on the axis of two or more streets, converging on the plaza. The accompanying plans illustrate several examples.

Where the rearrangement of streets is necessary to provide for terminal



Typical Situations for Railroad Passenger Terminals Located at Axis of Two or More Streets.

business, the cost has usually been borne by the municipalities, or by special assessment against abutting property, or by a combination of the two. In a few cases the terminal companies have borne part or all of the cost. It is understood that the cost of widening Canal Street in Chicago is borne by the Union Station Co., whose property it serves.

The Chicago Terminal Plan.—Probably the most notable example in this country of street planning and development to serve adequately a huge and comprehensive terminal plan is that worked out by the Chicago Plan Commission and now being adapted by that commission in conjunction with the railroads and other interests and carried out in construction by the board of local improvements of the city and, in the case of the lake fro improvements, by the South Park Commission. The general plan is i lustrated. At this time the ne Michigan Ave. bridge and the lowe level crossing from the Illinois Cen tral yards under Michigan Ave. hav been completed. The Roosevelt Roa project is under construction. Th South Water St. project is under ord nance; the outer drives along the lak are definitely projected; and th Market St. project only waits for final settlement of the terminal plan to take concrete shape for actual con struction.

From this discussion certain defini conclusions may be briefly stated. I planning and developing the stre system of a city the traffic to an from and between railroad termina must be considered as one of the ma factors, and the plans must definitel propose to serve this traffic. Suc plans can sensibly and adequately b prepared only by the co-ordinate effort of the various interests con cerned; municipal, railroad and pr vate. The necessary studies inclu not only the present tendencies traffic increase but also a fundament examination of the future growth an development of the city and its indu trial, business and residential district In some cases it is reasonable charge the cost of necessary street r arrangements to the terminal im provement itself. The whole questio has a direct and vital relation to th orderly growth of the city as a whol

It seems unnecessary to sugge that our cities need not stop wi small measures when heroic projec are necessary. When it is consider that an unnecessary delay of five mi utes to each vehicle and one minu to each pedestrian in the traffic pr duced by the Chicago terminals onl would correspond to an annual ec nomic loss of at least $2,000,000, an that several times this amount will b saved by the completed street pla now proposed in Chicago, the feas bility of improvements on a larg scale is demonstrated. The actual a complishment on the huge Chicag project indicates that farsighted ob jectives can be realized when the en gineers are inspired by great dream and are working on a sound found tion of facts and common sense.

Methods of Grouting in Shaft Sinking

Extract from Article, "Present Practice in Design and Sinking of Mine Shafts," in May Proceedings of Engineers' Society of Western Pennsylvania

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The handling of water which is encountered in the sinking of shafts depends largely upon the amount of water and the nature of the rock. Grouting is the only method of preventing the water from coming into the shaft, and today provision for the sealing of water by injecting cement into the fissures of the water-bearing

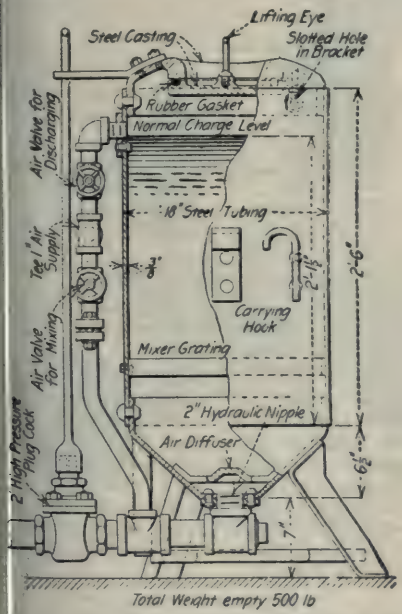


Fig. 1—Grout Mixing Tank and Connections.

strata is a part of all specifications. Today, all prices in contracts for sinking shafts are based on the assumption that if water is encountered grouting will be started and paid for according to provisions in the contract. Usually grouting is paid for per barrel of cement injected, but it would seem that a method fairer to both parties would be an agreement to pay for the cost of grouting on a basis of cost plus a fee per barrel, the fee to include the use of the contractor's plant, and his profit. The grouting clause and its price today takes the place of the water clause in the contracts of 12 and 15 years ago. This clause in former contracts provided for additional prices per vertical foot sunk in case certain quantities of water were struck, the prices to increase as the quantity increased, but this was an inequitable manner of paying for the cost.

The fairest water clause for pumping is the one based on paying by the million-ft.-gals. for all water pumped. This form of water clause (in addition to the clause for grouting) was used in the contracts for the shafts and tunnels for the Catskill aqueduct which was completed several years ago.

The First Use of Grouting.—In grouting, cement mixed with water to the consistency of cream is forced into the crevices under high pressure through drill holes in the rock, or pipes through the lining. The process was used first in shaft sinking in this country about 1910 on the construction of the Catskill aqueduct, although in Germany and in Northern France the principle was used several years before in cementing around the outside of the shaft before sinking was started.

Resistance Fundamental Requirement of Grouting.—The fundamental requirement to grouting is resistance. You cannot grout a length of 2-in. pipe open at both ends, but plug one end and you can pack it full of grout under pressure, and it will be solid and very dense.

If the ground 4 or 5 ft. above the stratum is solid, the grouting can be done very easily. If the strata above the water-bearing seam are full of crevices, naturally or through shattering, these cracks will allow the grout to work out because there is not enough resistance to the pressure of the grout. Such a condition will often take care of itself by the gradual setting of the thin layers of cement in the cracks, and the forcing in of additional cement at low pressure on successive days. Often oatmeal, bran, or dry sawdust is forced in with the cement and settling in the water seals the cracks. If the cracks in the bottom of the shaft cannot be sealed in this manner, it is necessary to put a

concrete mattress over the shaft bottom to provide resistance. This scheme, while expensive, has always been successful.

The Grout Mixing Tank.—The grout is usually mixed by compressed air in a grouting tank, as in Fig. 1, and forced into the crevices by turning the pressure of air in at the top of the tank; or the grout may be forced into the crevices by a pump, with equally good results. The scheme of grouting in rock in the shaft bottom is shown in Fig. 2.

The pressure used in grouting varies greatly according to conditions. If you are grouting in solid rock, the higher the pressure the more efficient will be the grouting. Usually with a grout tank you will use up to 125 lbs. pressure. If you are using a pump, the pressure available is limited, of course, by the steam pressure and the ratio of the cylinders on the pump. In several cases on the Catskill aqueduct grouting was done under pressures as high as 500 lbs., and my recollection is that in one or two cases a pressure of 600 lbs. was used through the use of special equipment. Little high-pressure work is done in this section.

Grouting Behind a Shaft Lining.—In grouting behind a shaft lining special care must be taken to gage the pressure properly, and definite results can never be guaranteed. If the holes to be grouted are in a round shaft, or in round ends of a long shaft, they will, of course, stand more air pressure than in the flat side of a shaft, but it is practically impossible to force grout behind a lining with less than 20 lbs. of air, and the possibilities of breaking a flat lining under even 20 lbs. of air are very great. When grouting behind linings was first started, pans or blisters of tin were usually put against the rock rib where the water ran out when the lining was being poured, and a hole was punched in the tin from which a pipe led to the concrete lining form, and the grout was forced through this pipe. This is still done in many cases, but if it is possible to drive a pipe into the water-bearing crevice and calk the rock seam so that all water will lead into the pipe, a much better grouting job can be done, for higher pressures can be used since there is not the area of lining over which the pressure of the grout can act.

Grouting in Slopes.—Grouting in slopes is a more difficult proposition. Since the strata are usually horizontal, the grout injected into the crevices must travel over a greater area to be effective. In water-bearing country it is wise to keep a test hole ahead pointed downward at a greater angle than the angle of the slope. If water is struck, more holes are drilled and grouted to refusal, but in driving a slope through a horizontal water-

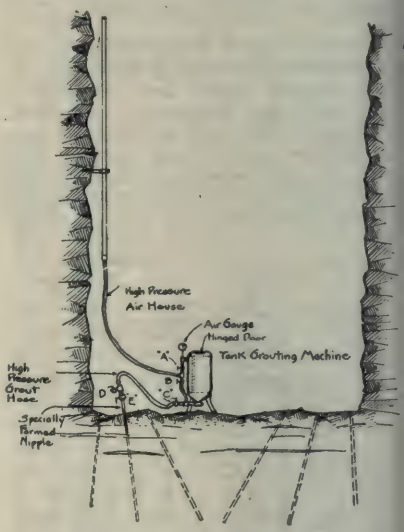


Fig. 2—General Layout for Grouting Operations in Shaft Sinking

bearing crevice it requires a long horizontal distance to get beyond the drainage area of that crevice, so that the sealing of water from a single crevice often requires several grouting operations. Each operation requires not only the time for the injecting of the grout, but a longer time to allow it to set before again shooting the face.

The Timber Shortage.—Col. William B. Greeley, chief of the United States Bureau of Forestry, warns that the predicted timber famine has already overtaken the eastern and central sections of the United States. Colonel Greeley says that smaller and poorer houses are being built in those sections, timber is being destroyed faster than it is being replaced, quality is growing poorer and prices are becoming higher.

Transportation—The Ateries of Commerce

nportant Elements Discussed in Paper Presented June 11 at 53rd Annual Convention of American Society of Civil Engineers

By J. ROWLAND BIBBINS
Consulting Engineer, Transportation, Washington, D. C.

At the time of the Civil War the ilroads of the United States handled 0,000,000 tons of revenue freight r year; at the end of the century, 000,000,000 tons; today, 2,500,000,000 ns. What does it mean to lift 2,500,-0,000 over 180 miles average haul, so 1,250,000,000 passengers an aver-e of 40 miles. One naturally thinks st of 400,000 miles of railroad and rminal tracks, 2,500,000 cars and ,000 locomotives to haul this traffic. it there are over 15,000,000 gross ns of shipping big and little, 45,000 les of electric railways, 12,000,000 otors and 2,500,000 miles of high-y, of which 186,000 miles are al-ady designated as the main im-oved road system of the country. l of these agencies form part of our ansportation system. And we should t neglect a little matter of 2,250,000 tons of parcel post and 7,600,000 tons of express matter, all of which is largely high-class, expedited freight tonnage. Parcel post, in fact, has become the biggest merchandise business in the world, which has twice doubled its tonnage within a period of seven years.

Load Characteristics.—One neglected aspect of this great transport plant is that, in no small degree, it is a problem of financing a peak load just as in the case of a power plant or street railway. These peaks occur every fall season with the movement of commodities, also with every wide fluctuation in the business condition of the country as a whole. Usually the railroad commodities loading increases between spring and fall months by about 30 per cent, then drops abruptly in mid-winter to about

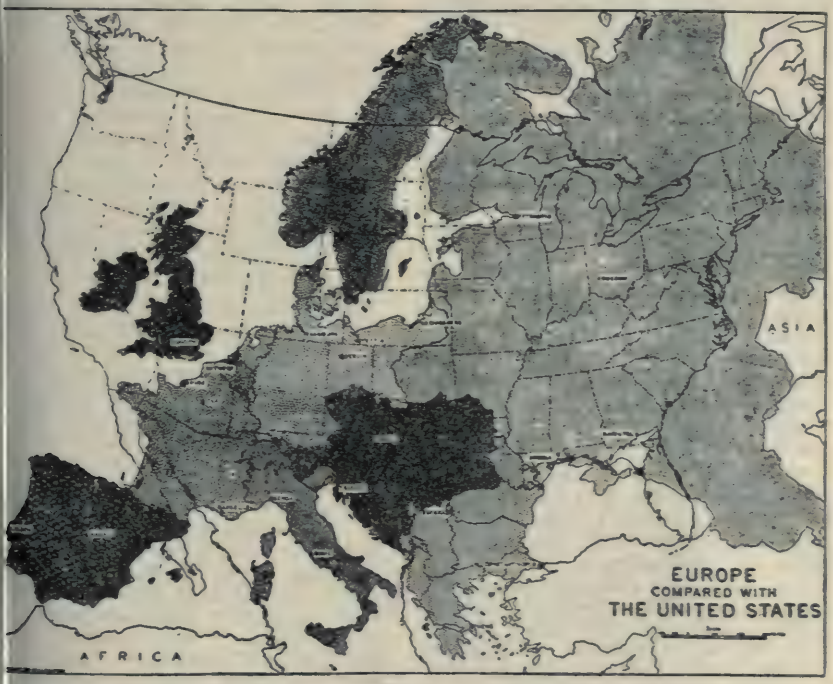


Fig. 1.

40 per cent below the October peak. The fall peak of the northwestern district is about 60 per cent above spring.

The reflex of business condition is shown by the fact that between January and October, 1922, the railway car service ranged from a surplus of nearly 500,000 cars to a shortage of nearly 180,000 cars, representing within 10 months a swing of over 25 per cent of the car equipment of the country or perhaps 75 per cent of the average number of cars loaded weekly throughout the year.

On top of this comes the continuing problem of normal growth and the present situation is worthy of hopeful comment. Business activity is widespread. Revenues and tonnage are moving to new high levels. Last fall occurred practically the highest loading and car shortage in railroad history. Instead of a normal traffic drop in the spring of 1923, the railroads recently reached a spring loading equal to that of the maximum fall peak loads, of 1922 and 1920, with only a fraction of the car shortage which occurred last fall in handling the same traffic. Here is an evidence of the flexibility of the system when unhampered by labor conditions or feverish business demands of a nationwide character. But while we may felicitate on present good fortune, this does not necessarily imply a solution for the future—which is one of the main objects of this discussion.

A Long-Haul System.—America is pre-eminently the long haul country of the world and is vitally dependent upon its rail carriers. Compare the 1,000 to 1,500 miles of haul to seaboard from our granger states with the comparatively short haul of 200 or 300 miles for grain from Argentine, Morocco, Australia or Southern Russia, which sends its grain to sea by waterways. It is said that a country's prosperity is based upon its surplus production, and it is more truth than fiction that what the American farmer receives for his grain is directly dependent upon the world price established at the local market at Liverpool less the cost of transportation; not the cost of his production plus transportation. Even the long water haul which our competitors in the various parts of the world have to endure is not as serious as the long land haul necessary in our country. For roughly speaking the cost ratio of water and rail haul is about 1 to These factors are what produce tra routes. And it is possible to outli quite definitely, various "Econom Divides" running diagonally acro our country, tracing the competiti points of movement from the interi to various overseas points by Nor South, Gulf and Pacific ports. this theory of the country as a gre economic drainage basin, the gre arteries of commerce—the railroads must provide the logical channels movement dictated by economic nee and conditions throughout the wor as well as here. The fact that t preponderant movement is now e and west across the Appalachi range, simply reflects a natural velopment under the urge of Eu pean demand. But the South Se are rapidly drawing from the Nor often resulting in the famous "tra triangle" so much prized as an an dote for empty European botto homeward bound. In fact the gre development of southern and weste ports points to a gradual shifting the "trade vector" southward. T railroads will have to meet this situ tion as it developes.

Rate Control.—This great railro network of some 265,000 miles of li is clearly the main stay of our tional life. And the rate system, t most sensitive part of the mechanis whether rightly or wrongly, has sulted in the establishment of the sands of communities where fores and deserts formerly existed. It evident that a considerable distorti of these complex rate relationshi must inevitably force a gradual re justment of the location of industri due to the relative importance of t factors of labor, raw materials a transportation. For instance, dou ing rates of seaboard would me that the great grain producing terior would suddenly be thrust tw as far into the interior as compar with seaboard production. In fact is conceivable that greatly distort long haul rates might result in t forcing of all industries to the co gested seaboard.

Decentralization.—But this is actly the opposite to a policy whi will bring about a homegenous nati with as nearly uniform distributi of population as topography and cli ate will permit. The railroads a the rate structure are the most i

rtant elements in this national con-
ol of settlement. There is a great
ed of decentralization both in pop-
ation and industry, not only coun-
y-wide but also in the cities them-
lves. While the growing percentage
city population may be due simply
accretion rather than migration
om the country districts, it is clear
at it has brought about problems
city congestion which may soon require drastic treatment. Highway development is undoubtedly aiding in this decentralization. But the railroads are the main avenue through which this desired redistribution will be brought about. And it is not inconceivable that such further decentralization may gradually help to cure labor troubles with which the country is afflicted especially in the congested centers.

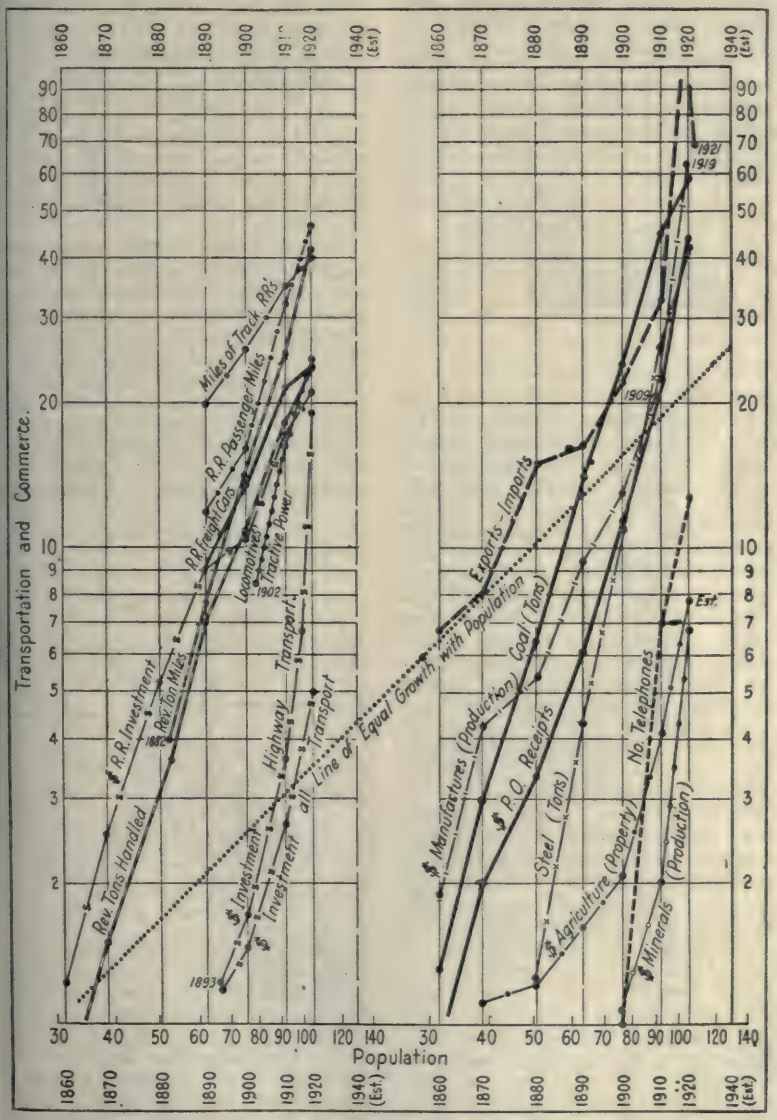


Fig. 2.

The Future a Large Problem.—To visualize the probable demands of the future, attention is drawn to an original study made by the writer on transportation growth and development of the country. The logarithmic diagram Fig 2 traces the general trend of investment, facilities and commerce since the Civil War in relation to the population growth of the country. The uniformity of these trends is most striking—most of all the basic curve of "Revenue-Tons Handled" which is here practically a

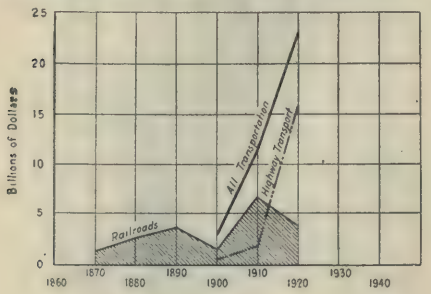


Fig. 3.

straight line, its divergence from the tonnage curve simply reflecting the increase of average rail haul throughout the country. (Oregon apples, California spinach, Colorado mellons.) If today we could press a magic button and double the tonnage capacity of the railroads, this curve shows this expedient would last, perhaps only 15 years. For this tonnage has doubled in 12, 14 and 18 years successively. Then if we assume a reasonable population of 130,000,000 people by 1940 a revenue traffic of nearly 4,000,000,000 revenue tons per year must be provided for. To meet this growth at least $10,000,000,000 new capital must be found, if invested along present standards.

"Commerce" has moved upward quite as fast—viz. coal and steel production, manufacturing and post office receipts (a good index of small business). And the farmer has not suffered, judging by the striking increment in value of farm property. In fact by 1940 farm and forrest tonnage will probably equal the tonnage of the entire country in 1900.

Capital Input.—But most striking is the investment in highway transport as compared with that of the railroads. This is shown by better advantage in Fig. 3 representing Capital Input in 10 years periods. Thus for the decade ending 1910, Highway Transport commanded about one-third of the capital put into railroads; in the decade ending 1920, it commanded four times as much capital as railroads, i. e., approximately $16,000,000,000, out of a total for all transportation of $23,000,000,000, against $4,000,000,000 for railroads.

These facts indeed challenge attention. While the gross railroad investment per ton handled has reduced from about $17 in 1880 is around $8.00 today, little reduction has been made within the past twenty years in spite of greatly increased traffic and efficiency—a fact that seems to indicate that the majority of the new capital has gone into expensive terminals, which is also indicated by an anaylsis of the track mileage additions through the years.

Status Today.—The investment situation today is shown in a general way in Fig 4 representing an engineering estimate approximating the pre-war level of values without deduction for accrued depreciation or such violent depletion in values as in shipping, brought about by the absence of a "going market." This estimate shows that Transportation is the second industry in the United States costing approximately $50,000,000,000

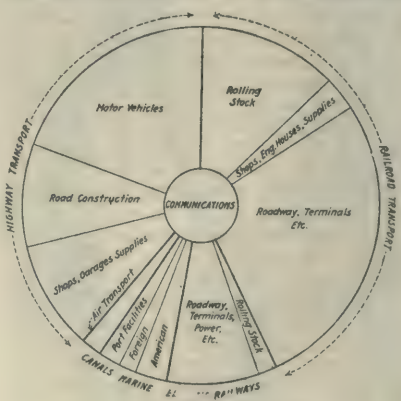


Fig. 4.

to build, which is about twice our national debt. It is next to Agriculture, $80,000,000,000 and exceeds Manufacturing, $45,000,000,000. In general terms, the cost ration is approximately 2-2 for Railroads, Highways transport and other agencies respectively. This great transport plant has grown from $14,000,000,000 in 1900 to $26,-

000,000,000 in 1910 and $50,000,000,000 in 1920. Railroads held the stage from 1900 to 1910; highway transport and shipping since then. It would be a wise prophet who could foretell the future cost of highway transport.

By 1940 if all transportation increased only as fast as railroads, by 1940 $25,000,000,000 new capital will be required at the minimum with probably $25,000,000,000 more for replacements of depreciable property retired. It is incredible that railroad development is going to recede. It is more likely that other transport will advance so that these total figures are probably far to conservative.

Does not this analysis point out that the utmost economy in facilities and draft on the capital supply of the nation is a great public need particularly during the long drawn out process of war-time deflation; with the lowest possible transport cost per ton mile, origin to destination and the quickest possible service and turnaround, whatever the method used? Does not the fact that the cost of our highway transport plant has grown to nearly equal that of the railroads, and possibly 40 times that of inland water-ways construction, emphasize the need of a broader treatment of transportation of the future so as to include not only the Arteries but also the Heart and the Capillary system?

The fact is that the traffic of the nation has grown in geometric ratio to the population, while facilities in freight houses, team tracks, wharves transit lines and particularly streets, and roadways in the large centers have increased if at all only in artihmetic ratio. Thus railroad tonnage has increased nearly as the cube and ton-mileage nearly as the fourth power of the population. And terminal tonnage is probably increasing as the cube of the population, especially in view of the growing proportion of city population to the total in the country.

On the other hand, the motors are increasing far beyond the fourth power of the population and city motors probably as fast if not faster. Yet in the great majority of cities, practically nothing is being done to survey and develop the capacity of the street system for handling this enormous flood of passenger and freight traffic—for transfer and city destination. Instead building heights are being forced upwards which only intensifies the problem. In many cities today local transportation is becoming a crucial problem largely due to the interference of these conflicting sources of traffic.

Metropolitan Transportation Planning.—It is becoming apparent that our cities and railroads have many problems in common which would seem to gravitate to two immediate questions of national importance.

(1) A Metropolitan District Transportation Plan for the larger industrial districts, ports and gate-ways.

(2) Terminal Planning based upon such surveys which will merge into the larger Metropolitan Plan.

The elements of a Metropolitan Transportation Plan embrace:

(a) Streets and Highways.
(b) Transit—local and interurban.
(c) Traffic organization and regulation.
(d) Railroads—Passenger entrances and terminals.
(e) Railroad freight lines, terminals and clearing.
(f) Freight transfer and delivery, city and suburban.
(g) Port-terminals and barge terminals.
(h) Grade separation — way and traffic.
(i) Warehousing—local and marine.
(j) Air ports and airways.
(k) Industrial expansion and Zoning.
(l) Relation to the general City Plan—governing all other city features such as parks, public buildings, schools, water supply and drainage, and all other matters of city welfare.

Boston, Chicago, Los Angeles and Baltimore are considering such metropolitan planning, and in the interest

(a) Some evidence of possibilities in this regard is offered by the American Railroad Association's betterment program for 1923 which encourages, as its major feature, higher efficiency in railroad operation by increasing the daily mileage of the average freight car, the average load per car handled and decreasing the number of bad order cars laid up. This very moderate program of betterment could probably add over 20 per cent to the existing service capacity of the rail system without additional equipment of capital investment. But no such program can be a complete success without the proper cooperation of the Public and its delivery agencies which in the last analysis simply recognized the fact that transportation is after all a complete movement from origin to destination and that terminal delivery as well as the rail hauls are involved.

of the major carriers of the country, the railroads, it would seem that immediate steps should be taken to develop in a broader way such an important phase of metropolitian plan as terminals.

Various government agencies are at work upon the vastly important subjects of consolidations, labor, rates, valuation, etc. Assuming, of course, that a fair solution will ultimately be found, it is perhaps no exaggeration to say that the larger question of future transport will undoubtedly focus in the terminals and that some form of physical, financial or operating unification will be evolved to insure command of the transport situation;—i. e., that terminal evolution in the gateways and large centers offers the greatest opportunity of increased capacity and minimum investment in which ship barge, motor and trolley as well as rail must each play its part. Here in a large degree lie the controllable wastes in transportation both off and on rail and it is evident that the maximum efficiency of the arteries of commerce—the rail lines—can never be secured until the heart of the system—the terminals—and their distributing agencies—are able to function as they should.

Terminal Planning.—A basic survey is of the greatest value in terminal planning to show the actual traffic movement and the relative placement and use of facilities. For cities very widely in traffic characteristics. Recent terminal surveys showed that in Chicago, (a), over half of the car movement is through interchange; in New York only about 17 per cent, (c), excluding the Marine traffic; the same in New Orleans, (b). Such a survey reveals immediate probabilities in the better use of facilities. Thus Fig 5 and 6 compare the **actual** and the useful work of a switching Belt Line in a large port terminal city—which is not equipped with clearing or storage yards and the necessary facilities to handle interchange outside of the congested centers. Here the largest part of the interchange (1), is actually done in the congested marine zone whereas it should be done outside at stragetic points of contact with connecting rail systems. In obtaining these results the writer, Engineer-in-Charge, conducted a complete origin-destination count of all freight traffic of the terminal district for a typical month.

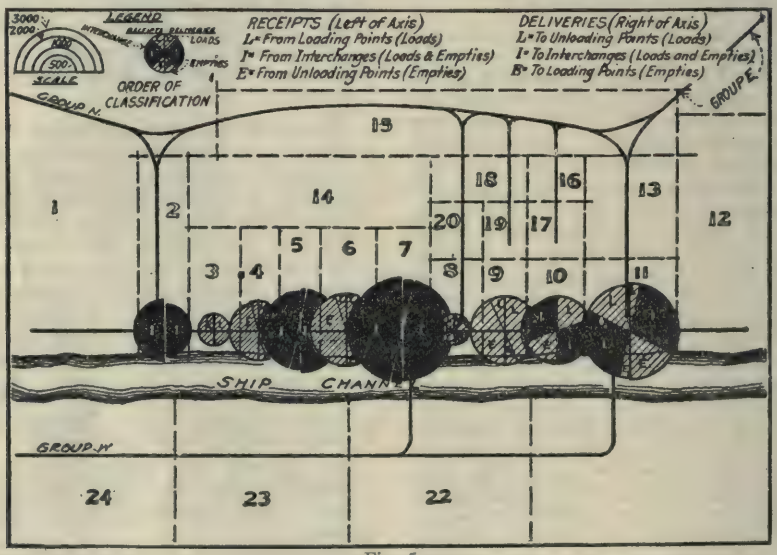


Fig. 5.

Terminal Band Values.—Such a survey should also comprehend a study of land values with respect to proper use and possible relocation. These values offer one of the greatest undeveloped resources of the railroads today. These values have

(a) Arnold report.
(c) Port of New York, Authority report.
(b) Board of Advisory Engineers Report.

grown by accretion of neighborhood land values until there values for commercial purposes are far above those for railroad purposes. It is probably not far from true that half of the entire railroad investment of the country is in other than mainline track, i. e., largely terminals. Generally speaking, the entire terminal system of the country is developed upon a one-story plan except in notable cases like New York and Chicago. In many cities, these terminal lands are strangling the future expansion of the business districts.

It is now a serious question of policy whether the roads can afford to retain these expensive properties in their present locations for single deck freight house and team track development in the face of their great rental value if intensively developed by the use of the "air-rights" and through the use of the motor truck for collection and delivery. One Chicago road found that it could afford to recede its inlying terminals 2 or 3 miles south using motors for hauling all city freight, and still make a profit out of the operation, using the present terminals for office, warehouses and loft building development at an additional profit from rentals.

Thus it may be that motorizing terminal service may become an interim measure which will largely increase terminal efficiency and release these tremendous land values for further profitable development, more in consonance with the needs of the city and districts where in they are located. The development studies in New York and Chicago are cases in point, and there would seem to be much opportunity for progress in New England, particularly Boston.

Figure 8 shows in a striking way the situation in Chicago where Loop land values are greatly exaggerated due to the iron band of rail operations surrounding the Loop. It is obvious that Chicago cannot expand until some re-organization of terminal facilities takes place especially toward the south and probably with a recession of the freight operations to a point where this tonnage debouched upon the public streets will not be so concentrated as at present. When the "Valleys" are filled up the enormous capital resources in these reclaimed lands will be realized as in the Park Ave., development New York.

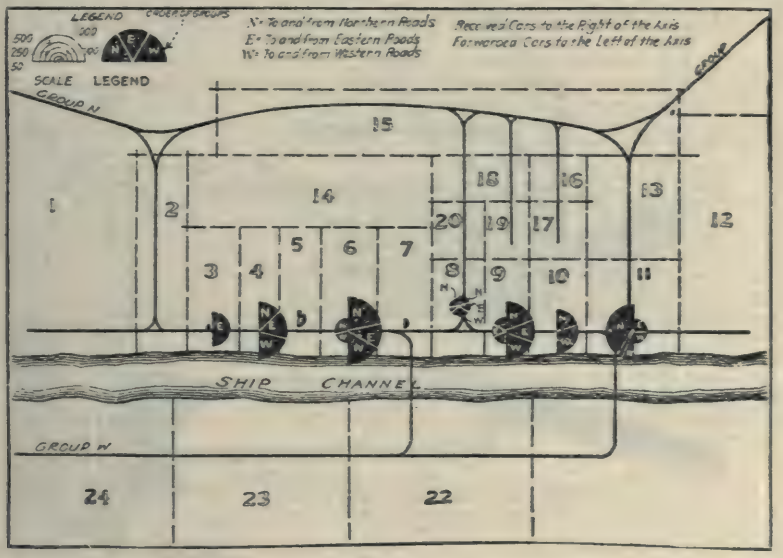


Fig. 6.

Motorways and Rapid Transit.—Here it is appropriated to direct attention to the future strategy of more effective use of the immensely valuable railroad rights-of-way entering our city terminal districts. These rights-of-way in many cases are well located for heavy motor-ways alongside to handle the city freight from

the receded freight terminals and also for rapid-transit lines from the development of which the railroads may better participate in commuter business and at the same time save the community duplicate investments in parallel rights-of-way for subways and elevated lines which can only be procured today at a tremendous cost for land condemnation and damages. By such a joint plan it seems clear that very large savings both capital and operating expense could be made for the benefit of all, and more important still, such accommodation of rapid transit facilities would relieve the railroad from the heavy capital burden of maintaining monumental passenger stations for a type of business which should be carried on rapid transit rails with their stations distributed through instead of concentrated at one point in the business district.

Accounting.—It is a curious fact that the accounting system of the Interstate Commerce Commission does not provide a setup for the specific determination of terminal costs. Some of the larger roads have made these determinations independently and the results are striking. Recently one road in the Chicago gateway found that it cost them nearly 40 per cent more than the per diem received to switch a foreign car over its lines and various estimates are on record in which the terminal costs were equal to the cost of a 400 or even a 1,000 mile haul. On the average it is probably not far from true the terminal cost loading on the country's freight is more than the cost of rail haul for the average distance hauled—about 180 miles, and with a further refinement of terminal accounting this equivalent would probably be greater. In the motor industries this is one of the great issues today and adequate cost accounting has barely begun, owing to the laxity and unfamiliarity with cost factors of those in the business. But this alone will determine in the future the range of economic possibilities for the motor.

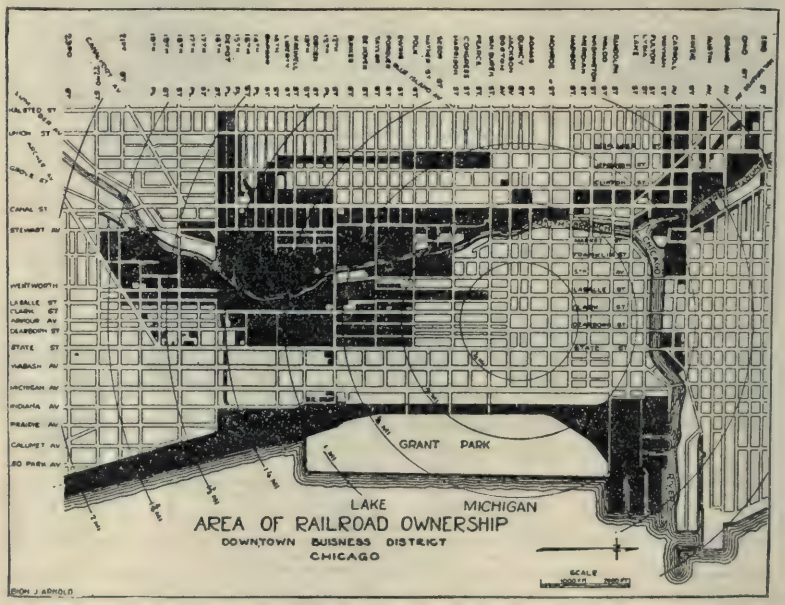


Fig. 7.

Street and Highway Capacity.—Another issue is clear, that if the railroad terminals are to be relieved by motorizing, serious study must be given to the problem of the capacity of streets and highways to serve them. This problem has received practically no thought or concerted action in the past and only the growing congestion of today has brought it to the front. Passenger and freight traffic is today interferring on our business streets to such an extent, as

to choke business and actually bring about a resession in values of business properties which should otherwise be on the increase. In Chicago, (a), just before the war a survey of L. C. L. freight movement showed that 60 per cent was transferred through the city to connecting roads; over half of it by trucks using the down town business streets; less than half by trapcars and freight tunnels. In Cincinnati, this trap car freight is now being handled between various stations by motor cars with interchangeable bodies, this traffic is all going through the business streets of the city. Here is another problem which must be solved in a reasonable way for the larger benefit of the entire community. It points clearly to the need of trucking by-pass streets and detour routes avoiding the central districts and yet giving the motor freight a chance to reach all parts of the city with reasonable speed. In Chicago, the first enterprise of this kind has ben started, known as the South Water Street Improvement. This will provide a wide, double deck detour thoroughfare around the Loop district, next to the river bank, with high speed vehicles above and trucks below. In addition, it will provide a very large automobile storage capacity at the boundaries of the Loop district for all-day storage of business men's cars, thus entirely avoiding the terminal congestion.

The Water and Road Arteries.—There should be no misapprehension in the minds of anyone analyzing national transportation as to the functions waterways and highways should play in the whole scheme. Both are districtly supplemental carriers, one long haul and the other short haul. In both cases, future development must envisage the integration of these systems with the great railroad network, in order to fulfill the proper demand of the American public for the best, quickest and cheapest over all transportation, origin to destination regardless of the method. America has but one great long haul internal waterway—the Mississippi and its tributaries, with its new canal connection with the Great Lakes. Such a waterway naturally constitutes a great intercepting trunk line for through-movement in large units between strategic rail connecting points.

It is difficult to see how such a waterway system can ever become of maximum utility without joint-rates and through-routes with the railroad system, due to the comparative limited littora which can be served by the waterways. In the interest of

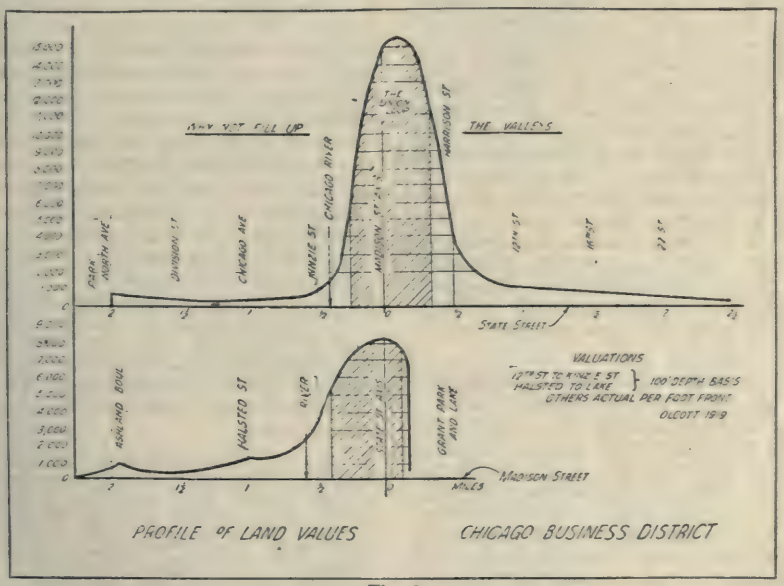


Fig. 8.

(a) Arnold Report.

national efficiency, it would seem that all the people should have the advantage of water-transport where they can use it to advantage. And under such circumstances, it is logic and justice that the economies of water-transport which will automatically develop with increased traffic should be reflected back in to the railroad system in some equitable manner through rates, so that both rail and water haul may participate in these economies. A system of contract-agency operation equitable to all parties could be devised to fulfill this condition.

Outside of the Mississippi system the Warrior is the longest navigatable river not even excluding the Hudson. This means that the majority of the inland rivers will be confined to local or comparatively short haul tonnage which must stop at seaboard until the inter-costal canal system is developed as a Water Belt Line inter-connecting all these river estuaries with each other and with all sea-board points and cities. As this whole waterway system matures and tonnage develops, water transport may reveal unlooked for economies especially if linked up with railroad hauls where economic conditions warrant.

The cost of waterway development will probably never mount into the large figures needed for rails and motor transport. It is demonstrable today that the total cost of developing the lower Mississippi, about $100,000,000 (less than half of which went into new construction) has been paid back many times by accretion in values and production within the territory now released from flood and destruction. This is Conservation, more than navigation. Who are the beneficiaries? Obviously not only land owners, but also the cities, highways and railways, State and Nation. Again the total cost of developing and maintaining the inland waterways of the country excluding harbors and estuaries, since the beginning of the nation's history is probably not more than one-half what the country spends in one year on public roads and will spend on railroads for the next year. There is therefore much idle talk about the "pork-barrel." When a fair operating plan is worked out by contract-agency or otherwise, by which these waterways can be properly intergrated with the railroad system, as they must be for achieving their larger usefulness the opposition will probably disappear over-night.

The Highway System is in very much the same category. Highways are the capillaries of the railroad system but only since the War has attention been directed to the fact that the great problem of collection and distribution of rail freight rests largely upon the highways. In fact it is demonstrable that it costs the country as much to haul freight to and from the railroad as to haul it on the rails and highways must in the end transport the greater part. Motor competition with the railroad sinks into insignificance beside the larger problem of efficient terminal collection and delivery. The economic relation of long and short haul costs, **road** versus **rail** is rapidly being developed by the Connecticut Road Tests and other studies and before long will be reasonably well known.

What is now needed is a better organization of the **off-rail** movement to and from railroads in order to release the full line capacity of the latter and enable the terminals to operate in **movement** rather than **storage.** This will provide a quicker turnaround not only for cars, but also for ships and motors themselves. It will provide the much needed "Vacuum pump" to clear the terminals more quickly.

It is a curious fact that the Transportation Act, 1920, does not visualize in any degree this function of highway transport as a railroad auxiliary in **through** transport, origin to destination. This places the burden of working out a practicable plan of coordination upon the carriers themselves. And there are evidences today of a sincere desire on the part of both motor and rail executives to unite on a better organization of this off-rail movement.

Cost and Benefit.—Another great need today is a better understanding of the economic relation of Cost and Benefit in these great public improvements, both waterways and highways. This lies at the verv basis of all Public Aids projects. The three most important elements in this problem of allocation are: (1) The general Public at large, (2) Property Owners and (3) The User or Carrier. The curve of rise in value of farm property

since the Civil War, especially since 1900, figure 2, indicates clearly that some effective agency has been at work. The same rise has taken place in city property where great public improvements are involved. Yet, while local district assessment has long been used for city improvement, tunnels, street widenings, etc., only a blanket assessment or general spread of assessment has been used in the country. Conservation has raised flood lands from practically no value to perhaps the highest value of farm lands in the state. Highway construction has brought farm lands to values corresponding with suburban property levels.

There is disposition on the part of some of the carriers to advocate placing upon the waterways and highways user the total costs of both development and maintenance, which must, of course, be reflected in the operating costs and rates of their new agencies. This does not seem to be either a constructive or far-sighted policy. And this is quite evident from the very reasonable assumption that ultimately, existing carriers may be enabled to use these waterways and highways for their own traffic, through some form of contract agency of even direct operation under proper regulation.

The real question then is to ascertain a fair economic division of costs and benefits for the good of the whole country. And in the case of highways particularly, it is probable that highway transport will soon drift down to a basis of true Cost-of Service just as in public utility properties today and that a Pay-as-you-use policy will in the long run bring economic stability to this new transport agency which has shown such remarkable virility in its development.

Caption 61—

Examination for Junior Engineer, U. S. Geological Survey.—The U. S. Civil Service Commission, Washington, D. C., has announced an open competitve examination to fill vacancies in the above position in the Water Resources Branch at an entrance salary of $1,620 plus $20 per month.

Track Mower Economically Produced by Attaching Car Wheels to Ordinary Farm Implement

From "Traction" Junior for July

Two 36 in. wheels, an ordinary standard farm mowing machine and a little ingenuity on the part of J. T. McIntosh, general superintendent, and W. E. McLaughlin, master mechanic of the Chicago & Interurban Traction Co., operating a line from Chicago to Kankakee, has solved the problem of weed cutting on this busy suburban and interurban road.

The mower was first modified by lengthening the axle a sufficient amount to carry out the wheels to fit standard gauge of 4 ft. 8½ in. This was done with a sleeve arrangement. Two 36 in. car wheels were subjected to the action of a cutting torch. The center of both wheels were then cut out, a hole 12 in. in diameter being made, and all the metal removed. The hubs of the mower wheels were inserted in these holes, the outer face of the mower wheels abutting the inside face of the car wheels.

Bolt holes were then burned through the car wheel to accommodate hook bolts for each of the spokes of the mower wheels. The hook bolts fit around the spokes and are tightened by nuts against the outer face of the car wheels, thus securely holding the mower wheels against the car wheels in proper concentric position. The use of 36 in. wheels gives about 1½ in. clearance for the mower wheels above crossing plank. In order to cover the hole at the wheel center a disc of sheet iron was put on the mower axle.

At the proper place to one side of the mower shoe, was attached a plate metal shoe to ride the rail.

Other than to lengthen the mower axle and attach the shoe, no changes were necessary in the standard mower.

A pivot attachment is used to couple the mower to the car. A line car is used to pull the mower and a special off center coupler is supplied to fit the off center pull of the mower.

The utilization of a standard mower with only two changes and the using of two old car wheels makes a very economical assembly for weed cutting. The whole outlay including labor for this equipment did not exceed over $100.

Some Phases of Present Day Railroad Transportation

A Paper Presented July 11 at 53rd Annual Convention of American Society of Civil Engineers

By J. W. KENDRICK,
Consulting Engineer, New York and Chicago.

The railroad system of the United States, as it exists today, constitutes a monument to the ingenuity of the civil engineer and his conferres, the mechanical and electrical engineer, for the science of transportation has come to embrace everything that is known in all of the applied sciences and is not the task or duty of one profession but of all these professions combined.

Anyone who traverses our great transcontinental systems, or the railroads of early construction extending through the Appalachian or other mountain ranges, cannot fail to be impressed with the accomplishment that they represent with respect to boldness of conception and wisdom of execution. Our engineers were obliged to build for the then present conditions. No matter how correct their concept of future development of the country might have been they were limited as to means and were obliged to consider the factor of economic worth of the facility when completed.

With the growth of business it became necessary for the railroads to improve their properties. This required the expenditure of enormous sums, and the additional investment justified increases in the rates charged for transportation, which were not forthcoming, however.

Early Railway Operation.—Until 1890 the operation of railroads was conducted along lines dictated by the comparatively short practical experience that had been gained. The necessity for the adoption of systematic methods was beginning to become apparent and early in the decade that followed there was instituted in the Northwest a system of reports as to current operation that, in a general sense, constituted the foundation of the present system of accounting prescribed by the Interstate Commerce Commission. Other movements of a similar character may have been inaugurated in other parts of the country at the same time, or earlier, but this particular movement affected in a very large way the railroad systems of the West and Northwest and, later, of the East.

Many of the Western and Northwestern railroads doubled their trainload during the ten years ended in 1900. Some roads had systematically reduced their grades, and all had improved the quality of their power to some extent. It is fair to say, however, that a large percentage of the improvement that took place in this period was due to closer and more intelligent supervision.

The records of the Interstate Commerce Commission are available for the history of the growth of the railroad systems and their business from 1890 up to, and including, 1921, though complete statistics are not yet available for the latter year.

Accomplishments of 1890 and 1920.—Comparing the accomplishments of 1920 with those of 1890, we find that the road mileage of all railroads in the United States increased 60 per cent, miles of all tracks operated increased 97 per cent, operating revenues increased 500 per cent, but operating expenses increased 760 per cent and, unfortunately, net operating revenues were 3 per cent less than those of 1890.

The tons of freight carried one mile increased during this period 440 per cent. Passengers carried one mile increased 300 per cent, and, be it noted, average revenues per ton mile increased only 13 per cent and per passenger mile only 27 per cent.

During the same period the number of employes increased 177 per cent, their total compensation increased 800 per cent, and their individual annual compensation increased 225 per cent.

During the same time, taxes increased 787 per cent.

The expansion of 1920 was, to a certain extent, spasmodic, and, as is well known, it was followed by a falling off in business in 1921. The onward march has, however, commenced again. The magnitude of operations in 1922 was greater than in the preceding year, but, whereas the tonnage is apparently going to be greater this

year than ever before, the revenues are not increasing in like proportion.

We have enjoyed the blessings of cheap and unlimited transportation for so long a time that the generations that were born in this era, and many who have survived the period when the railroad was still a struggling enterprise, have come to look upon it as a matter of course, have, in fact, come to look upon it as something that was given, if not by the Gods, by that portion of the public which, having faith in their country and their fellow men, invested their substance in railroad securities.

This country has fallen upon evil days in which it has become a matter of interest to some and an obsession in the case of others to preach the doctrine that the transportation systems of the country are owned by the representatives of concentrated wealth, and that in the processes of their operation the masses are ground down and compelled to pay extortionate prices for the transportation of their persons and property for the enrichment of these relatively few and enormously rich people.

Ownership of Railroad Securities.—A vast number of both men and women of the United States are in about equal proportions interested in railroad securities in small lots, not only directly as individual investors but also severally because of their participation in many great enterprises that are investors in railway securities, notably the companies that insure their lives and property, for it is a fact that 57,000,000 insurance policies are now in force in this country. The savings banks represent the same and other millions of citizens who are investors in railroad securities. The general public is again represented in great educational and charitable institutions which are investors in the securities of the carriers, so that the ownership of the railroads constitutes an important part of practically all that is best and noblest in a great country.

Rates must be sufficient to properly maintain the railroads. In no way can the people at large escape the cost made necessary by adequate rates. If taxation is resorted to it will bear upon those who have property which is taxable. Those who have property derive it from industry, by the employment of those who may not have property that can be taxed, but those who pay the taxes must collect the money from the general community in the dealings common in all society, so manifestly no one can escape.

Average revenues per ton and per passenger mile have shown little increase during long periods. although there were wide fluctuations in prices of labor, material and merchandise of all kinds.

The Mistake of the Past.—In the past we have made the mistake of being more concerned about the cheapness of transportation than about the ability of the railroads to handle promptly all the traffic offered. As a result of the constant pressure for lower rates, railway expansion was arrested at a time when there was a tremendous increase in the capacity for production. Recurrent transportation shortages during the last several years have served to prove that we are following a shortsighted policy. Good transportation is cheap at any price fairly commensurate with the cost of its performance.

It is well known that for many years practically all railway financing has been accomplished through borrowings, as investors have been reluctant to purchase the stocks of any but the strongest companies and thus assume the greater risk of partnership in the business. Railway capitalization has therefore become top-heavy with debt at the expense of the security of railway stocks. What is needed is the bringing of new partners into the business of the financing of railway expansion and improvement through the sale of stock issues.

Even our strongest companies have had to pay during the past few years for equipment upon a so-called equipment trust plan, which provides for a payment of part of the principal in cash at the outset and the balance during a term of years, a plan that does not enable a railroad to finance such an undertaking upon as good terms as it is entitled to receive, for such securities run only for a short period and command comparatively high rates of interest.

The Effect of Government Regulation.—The course of economic developments during the last 20 years throws much light upon the reason why the policy of government regulation which has been followed has produced the effect it has upon the development of our railroads. The Hepburn Act giving the Interstate Commerce Commission real power to regulate railway rates went into effect in 1906. At ap-

proximately the same time the legislatures of numerous states passed laws requiring reductions of freight and passenger rates and created or strengthened railroad or public utility commissions which themselves soon ordered reductions in rates.

We can now look back over the history of prices and wages in this country and determine beyond question that at this point there were beginning great economic changes which made this the worst time that could have been selected to commence to reduce railway rates. The history of prices shows that it was at just about this time that there began general advances in the prices of commodities which were due to worldwide economic conditions and causes. This advancing tendency of prices caused increases in the cost of living, and naturally prompted railway employes to seek advances in their wages. It is a matter of history that the first large advance in railway wages made in years occurred in 1907.

These advances in prices and wages tended, of course, to increase the operating expenses of railways. In consequence the railways in 1910 sought to make a general advance of about 10 per cent in freight rates. This was prevented by an act of Congress which authorized the Interstate Commerce Commission to prohibit any advance in rates which it found unreasonable, and by a decision of the Commission holding that this proposed advance was unreasonable.

Conditions in 1914.—While the Interstate Commerce Commission could and did prevent a general advance in rates, there was not and could not be legislation to prevent a continuance of the general increase in prices. The consequence was that in the year 1914, when the war in Europe began, the average wholesale price of all commodities in the United States was more than 16 per cent higher than in 1906 when effective regulation of railway rates was begun. In 1917, when this country entered the war, although the average railway freight rate actually was lower than in 1906, the average wholesale price of all commodities was more than 100 per cent high. In 1918 it was 128 per cent higher than in 1906. In 1919 it was 146 per cent higher, and in 1920 almost 183 per cent higher.

Of course, this general and almost unprecedented increase in prices caused a corresponding increase in the cost of living, and made necessary further advances in the wages of labor and in other railway operating expenses. Meantime, the railway regulating authorities continued persistently to refuse to make advances in rates which even approached these increases in prices. In 1919, throughout which year the advance in rates made by the Railroad Administration under government control was in effect, the average freight revenue per ton mile was only 13½ per cent higher than in 1906, and even the large general advance granted in 1920 made the average revenue per ton mile less than 70 per cent higher than it was in 1906, although, as I have said, the average wholesale price of commodities in that year was 183 per cent higher than in 1906.

Ratio of Operating Expense and Revenue.—One of the best measures of the prosperity of a railroad or any other business is the number of cents out of each dollar earned by it that is paid out for earning it, that is, for operating expenses. If you apply this measure to the results of railroad operation in this country before and since the effective and drastic regulation of rates was adopted it discloses certain significant facts. That is, that during the earlier period of less rigid regulation, say, from 1890 to 1910, there was only one year, namely, 1908, which was a year of depression, when the ratio of operating expenses to operating revenues of the railways exceeded 70 per cent. On the other hand, there never has been a year since 1911, when the Interstate Commerce Commission rendered its decision denying the railways the first general advance in rates for which they asked, that the ratio of the expenses of railways to their earnings has not exceeded 70 per cent, and in some years 80 per cent. It is also a notable fact that from 1911 on there was, until recently, a decline in investments in railroad facilities and in the expansion of the capacity of the railroads.

Reduction in Ton Mile Cost.—Apparently, the railroad situation has so far been saved in this country by the reduction of ton mile costs through the untiring and persistent effort to increase the net tons per train mile, which has offset, to a considerable extent, the enormous increases in expenses that have resulted from other causes heretofore mentioned.

The following table shows the aver-

age net tons of revenue freight hauled per freight train mile and the total freight train miles for the year named:

Year	Net Revenue Tons Per Train Mile	Total Freight Train Miles
1890	175	435,171,000
1900	270	492,568,000
1910	380	671,258,000
1920	647	634,294,000

In 1921 the net revenue tons per train mile only decreased to 596 (or 8 per cent) in spite of a falling off of over a hundred billion ton miles (or 34 per cent) from the total of the previous year.

It should be understood in what follows that the term "Variable Cost," means the expense of such functions of operation as vary in accordance with the number of trains run. It is obvious that there are various expenses, such as superintendence and wages of station employes, which are practically fixed regardless of the number of trains run, while there are others that vary in proportion to the increase or decrease of train miles.

Total ton miles in 1910 were about 256 million, and in 1920 they had increased to over 411 billion, or 61 per cent. I call your attention to the fact that, in spite of this increase, there was an actual decrease of 6 per cent in freight train miles. This performance is nothing short of wonderful, and explains the principal reason for the vitality and strength of our transportation system, which has been obliged to endure much. It is a grave question how long the railroads can maintain this wonderful financial resiliency.

The Reduction in Train Mileage.—In arriving at savings on account of the handling of an equal, or greater, tonnage with a reduction in train miles the items which vary with fluctuations in train miles have been selected from the analysis of operating expenses of Class I railways for the year 1920, published by the Interstate Commerce Commission. The expenses under the various heads were apportioned to freight train service according to the method prescribed by the Commission.

The total of these selected items was found to be $1,404,000,000, and represents 69 per cent of the total charges to the accounts from which those items were drawn, the balance being chargeable to passenger and allied services and arbitrarily apportioned to such services, and a small amount is unrelated to either freight or passenger services.

The total freight train mileage in 1920 was 634,294,101, so that the variable cost per freight train mile was $2.21.

In 1910 no attempt was made to allocate operating expenses to freight and passenger operation separately, but the combined cost of these selected items was $628,632,126, and if the same percentage was properly chargeable to freight service in that year as in 1920, namely 69 per cent, the amount of these expenses which was subject to variation, or fluctuation, with increase or decrease in freight train miles was $433,756,080, which divided by the total freight train miles run in 1910, or 671,257,888, gives 65 cts. as the variable cost of a freight train mile in that year, so that, upon this basis the increase in the variable cost during the ten years from 1910 to 1920 was $1.56, or 240 per cent.

While a portion of this increase is undoubtedly due to increased size of locomotives, by far the larger portion is accounted for by the tremendous increases in wage rates of train and enginemen, prices of fuel, together with the increased wages paid the various shop crafts, and other reasons that are well known.

The Wages of Railway Employes.—The wages of a standard through freight train crew, consisting of an engineer, a fireman, a conductor and two brakemen, increased 124 per cent during the decade under consideration; the price of locomotive coal per ton at the mines increased 187 per cent and wages of machinists (taken as typical of the shop crafts) increased 138 per cent.

These increased wages and fuel costs are, of course, due to changing economic conditions, but the rates received by the railroads for transportation should also vary in accordance with the same changing conditions.

In 1910 the average ton miles of revenue freight per train mile was 380, and in 1920 it was 647, an increase of 267 ton miles, or 70 per cent. The total freight train miles in 1920 was 634,294,101, and if the trainload had not been increased, that is, if it had remained 380 tons as in 1910, it would have required approximately 444,000,000 more trains to have handled the net ton miles of 1920. Multiplying this by the variable cost per freight train mile in 1920, $2.21, gives the astonishing total of $981,240,000.

Increase in tractive power of locomotives undoubtedly was a factor in this remarkable result. While it is impossible to segregate locomotives assigned wholly or principally to road freight service, it is known that the average weight per locomotive owned by Class I railways in 1910 was 73½ tons, while in 1920 it was 94 tons, an increase of 28 per cent.

In my opinion, the building up, or increase, in trainload has been due to increased weight of locomotives, greater capacity and heavier loading of cars, and to some extent to reduction of grades and elimination of curvature, but very largely to the supervisory movement for this purpose that has extended throughout the country.

Railroads Have Insufficient Working Balance.—It is evident that a decrease of a billion dollars per year, or even of half that sum, resulting from a period of lean business, which it would be impossible to offset by reduced operating expenses, would bring bankruptcy to many railroads. In other words, the railroads have an insufficient working balance and are receiving rates that are too low in view of the serious fluctuations in tonnage, regional or general, by which they are constantly threatened.

Increase in trainload during the decade ended with 1920 was responsible for a reduction of almost a billion dollars in operating expenses. The amount saved ($981,240,000) is equivalent to a rate of return of over 5 per cent on the property investment in that year, and also on the tentative valuation of the Interstate Commerce Commision for rate-making purposes, $18.900,000,000.

There is another point: Railroads have invested an enormous sum in passenger locomotives, facilities and equipment. If the subject of variable train mile costs were considered from a passenger standpoint as it has been from the standpoint of freight movement there would be a still further large sum for which the railroads would be entitled to receive credit on account of greater economy due to better devices and the superior quality of supervision with which they have been managed.

I would like to state most definitely and emphatically that the greatest reduction in expenses that has ever been secured in the operation of the railroads has been through the increase in train tonnage and the diminution in train mileage.

Railroad Operation Under the Transportation Act.—In conclusion, I quote from a pamphlet issued by the Association of Railway Executives, and entitled, "Three Years of Railroad Operation under the Transportation Act":

"The net operating income on Class I roads for the year 1920 was only $17,226,902. The guarantee by the Government for the six months' period, therefore, was the only thing that saved a large number of roads from bankruptcy.

"The statutory return, the net railway operating income, deficit below statutory return, and the rate of return, both on the property investment of the carriers and on the tentative valuation for rate-making purposes by the Commission, are shown in the following table. It is obvious from this table how much Class I roads fell below the realization of a return which was declared by the Commission to be, in its judgment, a fair return. Thus the public's transportation bill, as represented by freight and passenger charges, for the years in question was reduced substantially two billion dollars at the expense of a fair return to railroad owners on their property devoted to public use.

The Transportation Act became effective on February 29, 1920. It is the first act of constructive legislation affecting the railroads for many years. It should not be amended or changed in any way to adversely affect its value to the railroads or the public, i. e., it should be given a fair trial extending over such periods as may be necessary to point out the defects which it undoubtedly contains. To proceed hurriedly will certainly bring costly errors. It is sincerely to be hoped that a faithful observance of its provisions, both by the Government and the carriers, will prove its worth, but the railroads are entitled to receive a fair return on the value of their investment, and that the return has not been fair during the three years that have passed must be conceded by all fair thinking persons.

Year	*Statutory Return	Net Railway Operating Income	Deficit Below Statutory Return	Rate of Return on Property Investment	Rate of Return on Tentative Valuation
1920	$1,134,000,000	$ 17,226,902	$1,116,773,098	0.09%	0.10%†
1921	1,134,000,000	600,888,351	533,111,649	3.08%	3.29%
1922	1,094,625,000	759,946,000	334,679,000	3.82%	4.09%
Total	$3,362,625,000	$1,378,061,253	$1,984,563,747		

†Estimated.

*Six per cent on tentative valuation by Interstate Commerce Commission for rate-making purposes, years 1920 and 1921, and 5¾ per cent in 1922.

Trolley Construction for Heavy Electric Traction

Satisfactory Tests on Currents Exceeding 5000 Amperes Described in Railway Age of July 21, 1923

A new type of overhead trolley construction has been developed by the General Electric Company which is extremely flexible and which makes possible the collection of currents of more than 5,000 amperes from a single pantagraph. A series of tests to show the qualities of the overhead construction were made during this week on test tracks at Erie, Pa., for the benefit of a large group of invited guests.

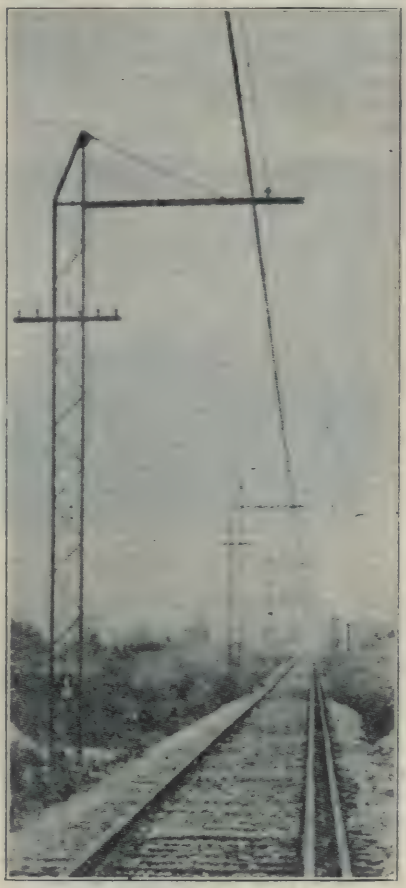
The test train consisted of a 110-ton passenger type locomotive arranged for operation on 750 or 1,500 volts and equipped with four bipolar gearless motors, a gondola and a New York Central observation coach. On account of the short length of the

A Section of the Overhead Trolley Construction.

cab, the second pantagraph was mounted on the gondola to simulate operating conditions. The normal pressure of the pantagraph against the trolley wire was between 30 and 35 lbs. By means of remote controlled contactors, sections of loading grids indicated in the gondola were inserted or removed so as to draw whatever current was called for under each particular test.

Some of the guests were invited to ride in the locomotive cab. Others rode in the observation coach which was equipped with indicating instruments to show the amount of current collected and the speed of the train.

Five tests were made as follows: 1. With the train running at 60 miles an hour, one pantagraph was used to collect 4,000 amperes at 1,500 volts. 2. At a speed varying from 50 to 60 miles an hour, one pantagraph was used to collect 4,000 amperes at 850 volts. 3. At 30 miles an hour, two pantagraphs were used to collect 5,000 amperes at 850 volts. 4. At 60 miles an hour two pantagraphs were used to collect 5,000 amperes at 850 volts. 5. At 58 miles an hour one pantagraph was used to collect 5,400 am-



Latticed Channel Bracket Pole.

peres at 850 volts. It was necessary to make the higher amperage tests at the lower voltage because of the limited power available. Witnesses of the tests stationed on observation towers remarked on the complete absence of sparking.

To provide facilities, the General

Electric Company made use of the eastern division of the East Erie Commercial Railroad. These tracks are equipped with up-to-date overhead line construction and third rail and are supplied from a sub-station with whatever trolley voltage may be required.

That portion of the track which is used for testing purposes is at present 23.4 miles in length. An extension is now under construction which will give a total length of 4¼ miles. The length of track used for high speed running is about 2½ miles long, the remainder being used for slowing down the train. Included in this high speed section, there is one mile of level tangent track. Beyond this tangent there is a slightly ascending grade with curves of from 1 to 1½ deg. The rail used is of 100-lb. section which is laid with 24-in. tie spacing in slag or stone ballast. There is also about one mile of extra rail which is used for testing odd gage locomotives.

The working conductor is located 22 ft. above the rail. The overhead construction is compound catenary with a steel messenger and a secondary copper messenger to which is "laced" duplex copper working conductors. The two contact wires are supported at alternate points by the lacing. A portion of the secondary messenger is 1,000,000 c.m. copper and the remainder 750,000 c.m. The overhead line is fed at one point from the substation in building No. 60 of the G. E. plant.

The steel supporting structures begin about 600 ft. west of the substation with latticed column bridges extending up to bridge No. 13. Bridges No. 14 to 18, inclusive, are Bethlehem column bridges. The structures from No. 19 to 23 are latticed channel bracket poles; from No. 24 to 28, inclusive, 10-in. Bethlehem bracket poles; from 29 to 33, inclusive, 9-in. Bethlehem bracket poles. Bridge No. 34 is latticed column type used for an anchor. The steel structures are spaced 300 ft. throughout. All of the steel structural work was supplied by the Archibald Brady Company, Syracuse, N. Y.

The primary messenger consists of a ⅝-in. 7-strand high strength steel cable, from structure No. 1 to 34. The secondary messenger is a 1,000,000 circular mil stranded copper cable between bridges No. 1 and 15, and a 750,000 circular mil stranded copper cable from bridges No. 15 to 34.

Test Train and Section of Trolley.

From bridges No. 1 to 16 and from No. 20 to 34, the working conductor consists of two 0000 grooved hard drawn copper wires hanging side by side. From bridges No. 16 to 20 two 000000 copper wires are used.

The laced suspension is installed throughout with a No. 0 stranded copper cable supporting the working conductors from the secondary messenger. Droppers from the primary messenger support the secondary messenger at points 30 ft. apart. The working conductors are supported from the secondary messenger by clips spaced 15 ft. apart on each wire.

To permit witnessing conveniently the current collection observation towers had been erected to a height of approximately the top of the pantagraph, at various points along the track.

The substation contains two synchronous motor generator sets with switching equipment suitable for connecting there units to supply any trolley potential from 600 to 3,000 volts. One of these sets has a rated capacity of 1,000 kw. and consists of two 500 kw. 1,500/3,000-volt generators direct connected to a synchronous motor. The second unit is of similar construction but with two 750 kw. generators. Full capacity can be obtained with both series and parallel connection, and lower voltages can be obtained by adjusting the rheostats in the generator fields. Both of these sets are designed to operate at three times normal load for short periods, and a total of 6,000 kw. can be obtained, the limit of the power supply.

Experiences of Electric Railway With Pressure Treated Wood Poles

In 1907 the Chicago, Lake Shore & South Bend Ry. installed 2,500 treated poles on its line between Kensington (Chicago), Ill., and South Bend, Ind., a distance of about 75 miles. The experiences of this railway with this installation are given by Howard H. George, in a recent issue of the Electric Railway Journal, from which the matter following is taken.

The poles were of Southern yellow pine, about 40 per cent loblolly; they were 45 ft. long, and measured at least 29¼ in. in circumference at the top and at least 39½ in. 6 ft. from the butt. The treatment was by the full-cell pressure process, with 12 lb. absorption per cubic foot. They were treated at Pascagoula, Miss., and Slidell, La.

The line runs through a slightly rolling country. In the section between New Carlisle and South Bend the soil is sandy clay and black loam. Between Kensington and Hammond the soil is black mud, and between Hammond and New Carlisle it is sand.

Poles in Good Condition.—The poles carry an average equipment of two 10-ft. crossarms supporting single-phase and three-phase 33,000-volt circuits, telephone and signal lines, as well as mastarm trolley, etc. The poles were all set in concrete because of ground conditions.

The last official inspection was in November, 1922. At that time 60 poles had been removed, mostly due to the presence of woodpecker holes and consequent decay. A few had been burned by transmission lines, arresters being defective. At that time, the inspection report stated that there were a few more pools that should be renewed, but that the line generally was in fine condition and should easily give 15 years more service.

Of the poles, 1,290 (about 40 per cent loblolly) were treated at Slidell, La., in the following manner: The poles were first steamed six hours at 30 lb., 274° F. They were next subjected to a vacuum for four hours at 26 in. Oil pressure was then applied for one-half to one hour at 60 to 90 lb. English coal-tar creosote was used, and showed the following analysis:

Distillation

Temperature, Deg. C.	Per Cent
0 to 170	1.00
170 to 205	5.00
205 to 210	4.50
210 to 235	38.50
235 to 300	26.00
Above 300, residue	24.50
Loss	.50
	100.00
Specific gravity at 38 deg. C.	1.04
Tar acids, per cent	8

The oil used for treating 1,500 poles at Pascagoula, Miss., showed the following analysis:

Distillation

Temperature, Deg. C.	Per Cent
0 to 210	1.50
210 to 235	42.50
235 to 270	24.50
270 to 318	11.50
Above 318, residue	20.00
	100.00
Specific gravity at 35 deg. C.	1.047

These poles were treated without any preliminary seasoning, that is, some of them had been cut two weeks and some two months. The majority were cut from longleaf yellow pine or second-growth longleaf pine, although about 40 per cent were loblolly. They were steamed twelve hours at 35 lb., followed by a vacuum period of six hours at 23 to 24 in. It required from two to four hours at 100 to 125 lb. pressure to impregnate with 12 lb. oil per cubic foot.

90 Miles an Hour in France.—The General Electric Co. is completing a 120-ton locomotive for use on the Paris-Orleans Railway in France. This machine is expected to make more than 90 miles an hour. It is 62 ft. long and operates at 1,500 volts with gearless motors on two 3-axle driving trucks.

The College Graduate and His First Job

Some Useful Advice to the Newly Fledged Engineer Given in The Colorado Engineer

By ROBERT L. CATLETT

In this article, an attempt will be made to try to give you an idea of what is in store for you when you first turn to this serious business of making a living. The fact as to whether your four years have been properly spent is of little interest to you now. You want to get out and earn money and fame, lots of it, and in a hurry. You have a good education and you have confidence, but it is this confidence that is likely to cause the initial upset.

There is, perhaps, not one of you who has not the feeling that you possess unusual ability which is being held back for the "proper time." The proper time, of course, is, when in some meager capacity, you are drudging along the engineering field and the great situation arises, the solution to which, you, a young inexperienced graduate, are the only one to give at the moment. The result is both promotion, and a big boost in salary. Now and then such things do happen. History records such deeds at any rate. But we are not dealing with this 100 to 1 shot in this article. The only trouble with this whole scheme is that the situation you rise to meet so magnificently in your mind, is also a product of your mind, which, in turn, is the result of some assignment in your text book. No wonder you can meet it! Engineering practice but rarely is a party of the second part to such coincidence.

The foregoing may appear vague as an explanation of an upset in confidence, but it does justify the statement when it is said that your confidence is one-sided. In other words, you have never been closely allied with industry and you do not know what is required. To put it another way, the fellows with whom you now associate are of the same age and the same group with whom you have struggled through grammar school, through preparatory school, and lastly through college. Your ideas, your ideals, your very actions are the same. You have been in the so-called "protected atmosphere." You do not have, nor can you be expected to have, the practical conception of the manner in which business is conducted in a business man's way.

Now comes the change. You are going to associate with men younger and older, as well as with those of your own age; men who have not had as much education as yourself as well as those who have had the same, or more education than you. How are you going to get along with these fellows?

By this time you have tolerated in a bored manner advice which has been given you on how to become a success. You know you won't follow it, but it may be well to remember it, because in all events it will help you to place yourself in a self-appointed category later on. There is no group of people that dislike advice like high school and college graduates, besides, who is the individual who does not like to find out things for himself. You know full well the destination, but it is the experience of the trip that appeals before and which you regret later.

Choosing the First Job.—The matter of choosing your first job is also filled with a volley of advice. Some will advise going away from home, others that it is foolish; yet there is not one that will perhaps consider your temperament in offering a solution to your future. All advice in a degree is based on what that person would do if he himself were concerned. If you make your own decision on your first job, you will either justify your convictions for your future work if it is satisfactory, or you will satisfy yourself that your first impression was wrong and be willing to try something else. The second condition is the rule more than the first. In fact, an executive of the largest and most powerful corporation of its kind in the United States stated: "I have always been in favor of a young man just out of school changing positions every three or four months unless he happens to be in a position where he can secure varied experience. After about two years of this miscellaneous work a man is in a position to go into office, design, or business engineering with a much better foundation than

if he started into office work right away."

It might be well at this point to outline in a general way what a graduate is likely to expect if he chooses one of the many groups of industries to gain his experience.

Industrial Plants.—All industries can be classified under two distinct heads, production and merchandizing. Due to the wide range of products that are produced, it can easily be deduced that there is a range equally as wide, to which engineering is associated in realizing these products; that is, engineering may bear a direct relation to production in one factory, and in another only indirectly. The important point to remember in this regard is, that the greatest remuneration goes to those directly concerned in producing a product or in selling it.

Included in this group is the test floor experience, the details of which have doubtless been presented to you by this time. Opinion is about equally divided over the value of the time spent in this work. Usually those who praise it are those whose positions call for this experience; while those who discount it have never had occasion to apply the experience to the work they follow.

Wages paid while in this work are usually small, and the hours are likely to be long.

Let us consider the plant that has its own power plant, water works, refrigeration plant, etc., such as steel mills, smelters, or chemical plants. In addition to operation and maintenance experience, there is always a large amount of construction work going on at all times.

Many of these industries have no definite procedure for the graduate to follow when he is first employed. They simply start you in as a helper wherever there is a vacancy. You learn how a building is actually built by helping to build it; how a machine acts under actual working conditions by installing it, and then keeping it in operation. In other words, you put on a pair of overalls and learn to work with your hands as well as use your head. This sort of work throws you on your own resources and gives a reasonable latitude in demonstrating your ability.

You observe other men, how they do a job, how long it takes them to do it, why it is one foreman has the respect of his men while another is held in contempt. It is a course for which no text book has been written. You might term it a laboratory course in human nature.

Usually it is in this class of work that you get your worst "hazing." Regardless of how unassuming you are you simply shout, "I am a college graduate." It is in your manner and simply cannot be disguised from the practical man. The result is that you will perhaps be given some dirty, disagreeable job, not because the foreman has a grudge against you, but as one foreman put it, "I always give them that sort of work when they first come to me to see if they have any 'guts.'" As a rule, your conceit and false pride are the only things that suffer while going through this initial stage.

It would appear as though an attempt is being made to create the impression that the practical man resents a college graduate in general. This is indeed not the case. With very few exceptions they are eager to show you all they know if they are approached properly, and it is that ability to gain the respect of these men that can help you, which the foreman or superintendent is quick to observe.

Taken as a whole, this sort of experience is filled with long hours, hard, disagreeable work, and tends to break your spirit. Yet after it is all over you have just as much pride over having gone through with it as Charles M. Schwab, retired head of the Bethlehem Steel Co., gets in still being able to drive railroad spikes, which was his first job.

Another redeeming feature is that you can earn a wage equal to anything that is offered to a graduate due to the fact that you are on an hourly basis.

Public Utilities.—Under public utilities are included those industries which are subject to commission rulings.

If there is not a cadet or an apprentice course established by the company, the experience obtained with a public utility is about the same as can be expected in an industrial plant.

For those who choose a company offering a cadet course, a very interesting line of experience can be expected. It is two weeks in a "white collar job" followed possibly by two weeks of hard manual labor with some of the construction forces, and so on through the various departments until you have made a complete circuit of

each phase of the business. The amount that you learn depends entirely upon yourself; in fact, such courses are designed for your benefit because at that period your service would hardly be placed under assets on the company's balance sheet. Here again you will find, that what is looked for most in your conduct is how you get along with the men, whether you have enough initiative to go ahead without always being told, and if you show any signs of leadership.

After a year or so of such shifting about, an office job is offered, and you breathe a sigh of relief to think that at last you are to get into some real engineering. Gradually you realize the job you have is nothing but that of a high grade clerk, and furthermore that you are up against some real competition, because there are many other graduates ahead of you. It is from this point with its keen competition that you gradually begin to gravitate to work best suited for you. How far you advance depends entirely upon yourself because there is every opportunity to just simply drift along doing the work that is required rather than put up a fight against the keen competition in order to rise out of a rut.

As a rule, salaries are lower than those paid by industrial plants for the same degree of responsibility, yet it is a business that does not slump off materially during business depression.

Position in Foreign Countries.—For the man who craves excitement, a foreign job in most cases will satisfy the keenest appetite, but it is well to remember that American firms discount very heavily experience gained in foreign countries if the applicant applies for a position in the United States at the expiration of his commission.

In places like Central and South America, American and British exporting firms offer attractive salaries, transportation to and from the job, long vacations, bonuses and so forth, but require to sign a contract for from two to five years. Of course, this does not mean that you are compelled to stay the limit of your contract, but your compensation in the form of bonus is so arranged that you do not get full benefit of it until the expiration of your contract.

Several years ago, the writer had an interview with the representative of a large holding company regarding a position with a company which they operated in Guatemala, Central America. This is the manner in which the representative summarized the entire question of foreign jobs. "Before you think about going to a foreign country, especially Guatemala, you should know what you are going into. In the first place, Guatemala is in the tropics, and some cannot stand the climate. There are frequent earthquakes, and an active volcano is always on the job, and in case these fail to bring about enough excitement, revolution breaks out every so often. I myself went down to the tropics after graduating, to be gone three months. But the fact is, I have been back to New York only three times in twelve years. Many men are like myself. Once they start working in the tropics it is impossible to get them to work any place else."

The point seems to be a question as to whether you are willing to live in foreign countries for the rest of your life. There is no doubt about the opportunities that present themselves in many foreign countries at the present time, and for the person who has a restless disposition, one who knows full well that he could not make good by staying in small surroundings, a job of this nature may be the very thing that will help you find yourself.

No Infallible Prescription for Success.—As previously stated, attempt has been made to give an idea of what is waiting for you when you enter the practical field, but no attempt has been made to give a specific solution to the difficulties you will get into. If there exists an individual who could write an infallible prescription for success applicable to every one, a new billionaire would be added to the list and the world would not be half as interesting to live in.

There are going to be many times during the first few years out of school that you will be ready to give up the whole business. Advancement will not be fast enough to suit you, increases in salary will be infrequent and small, perhaps, and you will be thoroughly discouraged and disillusioned. At this stage you will no doubt ask yourself: "Is it I, or is it the Company? Why don't I advance faster?" You will signal out department heads about you who have not had college training, and wonder how they ever hold their jobs. Inexperienced graduates are very critical!

Yet all you need to do is look about you to see men who are a success and if you ask them they will no doubt tell you that they too had to "flounder" about before they found themselves.

"Finding" yourself and "success in this world is gained by taking advantage of things as they exist, and not through wasting time on talking about things as they ought to be or might have been."*

*Industrial Mnagement, November, 1922.

Cutting Concrete Piles With Dynamite

How an Otherwise Difficult Job Was Simply and Effectively Accomplished

By LIEUT. COMMANDER S. GORDON (C. E. C.) U. S. N.

Reprinted From "The Explosives Engineer," July, 1923

Since, in the construction of a reinforced concrete wharf at the Pearl Harbor Naval Station, the depth to which the concrete piling would sink could only be determined roughly beforehand, it was not surprising that the driven piles should come to refusal with the butts approximately 7 ft. above the desired level. The writer, having noticed the clean break made by dynamite when used to cut off timber piles below the mud line, decided to try this method for cutting off the concrete piles. After exploding a stick of 60% dynamite in a 1-in. horizontal hole cored at the butt of a test pile, the shattered concrete was cut away, the surface smoothed with carborundum, tests for cleavage made on the concrete with magnifying glass and hammer, and the reinforcing rods subjected to bending tests.

As both concrete and rods were found undamaged, holes were then cored around the butts of the remaining piles, which were shot in batteries of eight. This method enabled the whole piling to be sheared in a remarkably short time, and in no case was the disruptive damage found to extend beyond 18 in. from the center of the charge. By bending the exposed reinforcing rods into the beams to be carried by them, an excellent bond between piling and superstructure was obtained. That the wharf foundations were not weakened by the shots was shown after completion of the wharf when the damage done by a 250-ton coal barge, in capsizing alongside, extended no further than a small area of shattered deck, which could be repaired at a nominal cost, and did not in any way affect either the beams or the piling.

Concrete Piles Cut by Dynamite.

The Explosive Contractor

The Field and Equipment Required, Outlined by the Technical Division of the Atlas Power Co.

There are few vocations which offer more opportunities for expansion than that of explosive contractor. While it is not a profession, it is an occupation in which the field is unlimited and not over crowded as in many professional fields.

The handling of explosives is not particularly hazardous if ordinary precautions are taken, but in spite of this fact the lay mind is apt to regard explosives as something to be avoided and consequently is willing to pay a very attractive compensation to someone else to do the work.

An explosive contractor's duties require him to be in the open a great part of the time, leading a pleasant, healthful life. In the Northern States there may be about two months during a very severe winter in which operations with explosives are at a sandstill, but in the Southern States it is a year 'round occupation. Even in Northern States a successful explosive contractor is not idle. He is either giving talks on the agricultural use of explosives to Granges, sending out literature and calling on trade to line up business for Spring, or else selling explosives and supplies to quarries, farmers and other users of explosives. Cold weather does not stop an explosive contractor's activities, for he has non-freezing powders available, which can be used at any temperature no matter how cold.

How the Contractors Take Work.—The explosive contractor usually takes work at a firm figure. In some cases, however, he is paid per man per day for each man on his crew and explosives and supplied are paid for in addition. Some contractors work on a cost plus basis and still others charge a certain figure per pound of explosive used, which figure includes labor and everything.

The work done according to specifications at a contract price is generally the most satisfactory, both from the point of view of employer and contractor as the proposition is cut and dried in the beginning. Sometimes a clause is put in the contract freeing the employer from all liability against injury to person or property. The explosive contractor usually makes an additional charge for assuming this liability and to cover any contingencies that may arise. As accidents are very rare outside of an occasional broken window, this additional charge is a greater profit. A provision for Workmen's Compensation Insurance is sometimes written into a contract.

When the work to be done is of such a nature that it can be stopped at any time, such as clearing a large acreage of stumps or boulders, blowing long stretches of ditch, or subsoiling large fields, the employer and explosive contractor agree on a labor and material basis. The contractor charges for his own time and in addition a profit on each of his men and the explosives and other material supplied. On this basis work can be stopped at any time.

The cost plus basis, while guaranteeing the contractor against loss, is usually less profitable.

The method of charging per pound of explosive used is not always satisfactory. The contractor uses more explosive than is necessary in order to minimize labor and results in inefficiency and is a contributing cause for disputes.

In nearly every case the explosive contractor can save money for his customer by doing work with explosives that the customer would do by some other method. Employers will also save money by employing an experienced explosive contractor to superintend their blasting operations, as he will show how the work can be done better and quicker and save powder.

There is hardly any section in the United States that does not offer an unlimited amount of work for an explosive contractor. A live wire will find plenty of work anywhere—city, suburban or country. Some contractors use from 5 to 10 tons of explosives per month and in addition sell from 1 to 2 tons per month.

There are at present many successful explosive contractors operating all over the country. For example, in Indiana alone one contractor uses 80,000 lb. of explosives per year and employs several crews, another contractor earns over $800 profit in some months, and in other states there are explosive contractors earning from $2,500 to $8,000 per year.

Equipment Required.—Before en-

gaging in a business of this nature a man should be well equipped with two essentials: a thorough knowledge of explosives, their characteristics and uses, and a complete stock of supplies. The powder companies are always willing to give a man complete instruction in the handling, care, use, storage and properties of explosives in order that a man may become thoroughly familiar with them. In addition to this the powder companies will furnish instructive literature and also help them to get business through inquiries received at the companies offices.

Experience comes through training and it will soon become as easy for the explosive contractor to prescribe the proper dose of explosive for a given blast as for a doctor to prescribe the proper medicine.

The equipment which an explosive contractor needs depends on the extent of his operations. For the beginner the money investment is small. To start out successfully he should provide himself with the following list of supplies, increasing them as his business grows:

Small Magazine.
100 Blasting Caps, No. 6.
100 Electric Blasting Caps, No. 6, 4 ft. copper wires.
Blasting Machine, No. 3.
Cap Carrier.
Cap Crimper.
500 ft. Duplex Leading Wire.
2 lb. Spool Connecting Wire.
500 ft. Safety Fuse for Damp Work.
500 ft. Safety Fuse for Wet Work.
1½ in. or 2 in. Earth Auger.
Duplex Ditching Bar.
10 lb. to 16 lb. Sledge Hammer.
Steel Probing Rod, ¼ in. to 7/16 in. diam., 3 ft. long.
Cotton Gloves.
Powder Punch.
Ball of Twine.
Tamping Rod.

The following are not absolutely essential to the beginner but will be found very useful and needed much more as he progresses:

1½ in. Wood Auger.
Galvanometer.
Rheostat.
Thawing Kettle for cold weather.
Cap Sealing Compound.

No mention is made of the quantity of explosives to purchase. This will be governed entirely by the nature of the work he is to do. It is always well, however, to keep on hand in the magazine a case each of

Extra L. F. Dynamite, 60 per cent.
Farm Powder.
Straight N. G., 60 per cent.
Non-Freezing Farm Powder.

The Nature of the Work.—The nature of an explosive contractor's work is varied. When once established he is considered an authority in his locality on the use of explosives and this necesitates his giving talks before Granges, County Agents' Meetings and other bodies of men on the use of explosives for agricultural purposes. He is also called in to give advice to those desiring to do their own blasting or even to supervise the work for them. Having a magazine, he is in a position to furnish explosives on short notice. His work in the field will consist of such blasting operations as

Blasting stumps.
Breaking boulders.
Blasting ditches (this can be done at any season of the year).
Subsoiling (should be done when the ground is dry, preferably in the fall after harvest).
Draining swamps (there are 75 million acres of swamp land to be drained).
Excavating cellars or loosening ground
Blasting post and pole holes.
Road grading.
Removing trees.
Renovating orchards.
Planting trees.
Destroying burrowing animals.
Breaking ice and log jams.
Loosening frozen material.
Blasting concrete walls and foundations.
Quarrying.
Blasting out for fish ponds and swimming pools.
Blasting buffalo wallows in the West.
Blasting pine stumps for turpentine companies in the South.

There are dozens of other uses for which explosives are advantageously used. Some of these uses require the explosive contractor to be ready in an emergency. His experience will enable him at times to save much property through the judicial use of explosives in such cases as breaking log and ice jams and in checking the spread of fires.

Although there are many explosive contractors in the United States, the field has not been even scratched. There are opportunities awaiting in the four corners of the land for men to engage in this lucrative business.

Roadmasters and Maintenance of Way Association Convention

The forty-first annual convention of the Roadmasters & Maintenance of Way Association of America will be held Sept. 18, 19 and 20 at the Hotel Sherman, Chicago.

Committee reports, special papers, trips to industrial plants and entertainment comprise the program.

New Guard Plate for Railway Switches

One of the most expensive items of upkeep in railway maintenance of way is the repair and replacement of switch points. A device for the protection of the switch points has been placed in production by J. R. Fleming & Sons Co., Inc., Scranton, Pa. It is designed to reduce the wear on the ends of the switch point; to avoid wearing the extremities of switch rails to a cutting edge; to reduce the shock of impact on the switch rails, and to overcome the possibilities of derailment on switches. It provides a guard plate which has an upper outwardly curved surface and which is rounded over to approximately the shape of the head of the railway rail. Chamfered corners are provided to receive the impact of the flange and thrust it laterally to separate it from the inner side of the rail head. Four bolt holes are formed in the guard plate to receive the fastening bolts, and the heads of the bolts rest in a channel plate made to conform to the space between the flange web and the head of the railway rail.

Mack Railway Switch Point Protector

5-Mile Extension at Alexandria, La.

The Alexandria & Western Ry. is reported to be calling for bids for the construction of a 5-mile extension at Alexandria, La.

Britain Speeding Up Passenger Trains.—On July 9 the British railways put into operation their full summer passenger schedule, including a number of new trains and accelerated timings for trains already in operation. The Great Western will have a new train from Cheltenham to Paddington (London) which will make the run from Swindon to Paddington (77¼ miles) in 75 minutes, or 61.8 miles per hour, the fastest train in the world. Other trains on the G. W. R. include a non-stop train to Exeter (173¾ miles), a non-stop train to Torquay (200 miles in 215 minutes) and many others. On the other railways similar improvements have been effected by the addition of new trains and the speeding up of existing schedules ranging from five minutes to more than an hour.—[Railway Age for July 28.]

Street Car Riding in America.—The people of the United States spend more than $900,000,000 a year for what is commonly called trolley car service. In the year 1922 the electric railways of the United States carried 15,000,000 more passengers than they did in 1921, according to estimates given out by Pennsylvania Public Service Information Committee. Fifteen billion passengers were carried on the electric railways of the country last year.

Construction News of the Railways

Track Elevation on Northern Texas Traction

The Northern Texas Traction Co. of Fort Worth has let a contract to Stone & Webster of Boston for track elevation to cost about $500,000.

Proposed Interurban in Tennessee

Leroy Parks of Greeneville on July 31 made formal application to the State Public Utilities Commission for permission to construct an electric interurban railroad from Bristol to Knoxville. He filed data and asked authority for constructing the road, assuring the commission that financing was positive.

Thirteen Miles in Missouri

Kansas City & Grandview Ry. has applied to the Interstate Commerce Commission for authority to build from Kansas City to Grandview, Mo., 13 miles.

Improvements by Pere Marquette at Lansing

Right-of-way has been procured by the Pere Marquette Ry. for the construction of nearly 15 blocks of track less than 200 ft. west of the present main line right-of-way through the city of Lansing, Mich. Switching tracks will be constructed along the new line for all leading east side industrial plants. Included in the plan is the moving of the Pere Marquette freight depot some distance south, to permit the proposed new line to branch westward from the main line at a point about where the freight house is now located.

Four Tracks from Pittsburgh to Youngstown

Surveys have been completed and within a few weeks the contract will be awarded by the Pittsburgh & Lake Erie Ry. for grading preparatory to the laying of two additonal tracks between Fallston and the Beaver Falls-New Brighton station. Ultimately the four-track system will be extended through Beaver Falls and the only other remaining two-track section of the road, west of New Castle Junction also will be widened by two additional tracks. With the work completed, Lake Erie will have a four-track line from Pittsburgh to Youngstown, its full extent.

303-Mile Project

A request for authority to construct an extensive new railroad system in Texas and New Mexico was filed with the Interstate Commerce Commission by the Texas, Pan Handle & Gulf Ry. The company proposes to build a line from Tucumcari, N. M., to Dimmitt, Tex., a distance of 303 miles, to acquire an existing 100-mile railroad from Seymour to Salesville, both in Texas, which is now operated by the Gulf, Texas & Western Co., and to construct an additional new line from Perrin to Fort Worth, both in Texas, a distance of 57 miles.

New Line in Washington

At the Wenatchee Southern hearing recently held by the Interstate Commerce Commission, Commissioner Clyde B. Aitchison announced that the commission would grant a permit to build a railroad down the Columbia river from Wenatchee to Kennewick, connecting with the lines of the Chicago, Milwaukee & St. Paul, Northern Pacific, the S. P. & S., and the O.W.

$3,000,000 Project Approved

Approval for the construction of a new railroad in Washington has been granted by the Interstate Commerce Commission. The Longview, Portland & Northern Railroad Co. will proceed with construction of a line from a point on the N. P. railroad near Kelso to Olequa. The cost is estimated at $2,991,772.

New Engine House at Erie, Mich.

The Arnold Co. of Chicago has received a contract from the Pere Marquette Ry. for construction of a new 16-stall brick engine house, and the installation of a 100-ft. turntable at Erie, Mich.

Oregon Short Line Permitted to Build 98 Miles

In granting permission to the Oregon Short Line Ry. to build 98 miles of new line between Rogerson, Idaho, and Wells, Nev., the Interstate Commerce Commission required the road to begin construction by Jan. 1, 1924, and to conclude it by June 30, 1925. The new line will shorten present railroad distances between San Francisco and Southern Idaho.

Okmulgee Northern Ry. Wants to Build 41 Miles

This road has filed an application with the Interstate Commerce Commission for authority to make a southwest extension of 15 miles and build a "cut-off" of 26 miles to connect with the Katy at Oktaha. The first line would pass through Okmulgee and Oksfee counties, tapping the Henryetta field, and would furnish fuel to industries around Okmulgee at a cheaper cost than from the more distant mines, as at present.

44-Mile Line in California

Approval for a plan of constructing 44 miles of new railroad in California has been sought from the Interstate Commerce Commission by the Minarets & Western Ry. Co. The line would run from Friant to Crane Valley Dam. No estimates of costs were filed.

Santa Fe Installs Timber Preserving Plant

The Atchison, Topeka & Santa Fe has awarded a contract to the Truscon Steel Co. for the material and erection of two of its standard steel buildings 50 ft. by 64 ft. and 32 ft. by 150 ft., respectively, for its timber preserving plant now under construction at National City, Cal.

Detroit & Mackinac to Build 12 Miles

The Detroit & Mackinac Ry. has been granted permission by the Interstate Commerce Commission to build a 12-mile branch line from Alpena to Rockport, Mich., at a cost of $154,571.

Extensive Plans by Long Island Railroad

This road will expend $84,000,000 in the next 10 years for improvements to uphold its reputation for carrying more daily commuters than any other American railroad, George Le Boutillier, vice president, stated recently.

New Passenger Station and Car Repair Sheds to be Built by "Q"

The Chicago, Burlington & Quincy R. R. has asked for bids for the construction of a new passenger station at Lamont, Ia. This company will also build a 600-ft. car repair shed at Dayton's Bluff, St. Paul, and is said to be asking bids for the completion of its new Chicago freight terminal.

Oregon Short Line Begins Big Job in Idaho

Awarding of the contract for construction of the Orchard-Boise and Nampa loop line, at a cost of more than $3,000,000, has been made, it is announced by H. V. Platt, general manager of the Oregon Short Line. The project includes the building of 27.78 miles of new track, 6.42 miles of side track, the rehabilitation of 14.19 miles of track on the Boise branch and the building of the new Nampa loop of 2.66 miles of track. The bid of the Utah Construction Co. covered the building of new depots at Nampa and Boise. The new line will put Boise on the main line of the Union Pacific to the northwest and will be standard main line construction throughout. The work will begin just as soon as outfits can be assembled by the Utah Construction Co., which should be in less than 60 days, Mr. Platt said. It is expected that the line will be in operation by next spring.

New Office Building for Nashville, Chattanooga & St. Louis

This company is about to begin construction of an 8-story office building at Nashville, Tenn.

Pennsylvania Builds in Ohio and Michigan

Authorizations for three big construction jobs—a third track from Crestline, O., to Toledo Junction, elimination of three grade crossings at Mansfield, O., and the construction of a new freight house at Cadillac, Mich.—have been made by the board of directors of the Pennsylvania. The entire work will cost nearly half a million dollars and is part of the Pennsylvania's program of improvements to provide better transportation facilities. The new track on the Toledo division will extend for about six miles, providing additional freight movement facilities into and out of Crestline. The construction job, which will cost $299,280, will probably be completed by November 1.

N., C. & St. L. Plans $250,000 Passenger Station for Paducah

The Nashville, Chattanooga & St. Louis Ry. plans the construction of a new two-story passenger station and office building at Paducah, Ky., to cost approximately $250,000.

23-Mile Logging Road Under Construction in Washington

A contract for the building of 23 miles of standard gage logging railroad north of Hayden lake into the Burnt Cabin creek district has been awarded to R. A. Biggs, construction engineer of Spokane by the Ohio Match Co. Announcement of the award was made yesterday by A. P. Bailey, general western manager for the company. While the amount of the contract is not stated, it is understood to be in excess of $400,000, with an average construction cost per mile of more than $17,000. In addition to this, the rolling stock will make it practically a $500,000 investment. Fifty men are already on the job and a force of between 300 and 400 men will be employed as soon as the details have been worked out. Work will be undertaken from both ends and from three intermediate construction camps along the line.

Cinder Handling Plant at Detroit

The Detroit Terminal Co. has awarded a contract to the Roberts & Schaefer Co., Chicago, for the installation of an electric cinder handling plant at Detroit, Mich.

Illinois Traction Plans $1,880,000 Improvements

The Illinois Traction System, the McKinley lines, is planning an expenditure of $1,880,000 on various improvements, among which are: A new power house at Venice, estimated to cost $1,200,000; track improvements at Burlington to cost $32,000; a $20,000 addition to its power plant in Peoria; $19,500 for the purchase of real estate with which to enlarge the yards at Springfield; $10,000 for an interlocker at Lincoln; $93,862 for a new turbine at Venice, and $25,000 for a new pump at Venice. There are about 50 other items for improvements, ranging from $3,000 to $6,000.

Atlantic Coast Line to Extend Double Track

The Atlantic Coast Line Ry. Co. has a construction force at work near Buie, N. C., putting in new cement bridges under the trestle and also making them wide enough for another track. The work is being done between Parkton, N. C., and Latta, S. C. Another track will soon be started between these places, making this division of the line a double track system.

New Shops at San Bernardino

Construction by the Atchison, Topeka & Santa Fe of two major shop units, costing nearly $1,500,000, including their equipment, will begin early in September. With the new units, a boiler and erecting shop, the San Bernardino shops will be the largest on the Santa Fe lines and employ more than 3,200 men. At present the shop personnel is 1,850 employes. The new boiler and erecting shops will be erected on a site now occupied by the old boiler shop, the first mechanical department building erected by the Santa Fe Ry. in Southern California. Construction will require several months. The buildings will be of concrete, iron and glass, the walls being almost entirely glass, giving adequate lighting and ventilation.

$2,500,000 for Track Elevation at Fort Wayne

The Pennsylvania Railroad is preparing plans for the elevation of its tracks at Lafayette street, Fort Wayne, Ind., at a cost of approximately $2,500,000. The necessary rearrangement of shops at a cost of $1,500,000 is included in the project.

New Power Plant for Brainerd Shops

It is announced that the Northern Pacific Ry. shops at Brainerd, among the largest locomotive repair shops in the West, are to have a new steam power plant added, for which the initial budget of the railway provides approximately $650,000.

Contract Let for 1,200 Miles of Railroad in China

Contracts for the construction of 1,200 miles of railroad in China involving an expenditure of about $20,000,000, have been received by the Northern Construction Co. of Vancouver, B. C. The new line will extend from Canton to Chengtu and will pass through some difficult country, necessitating the building of tunnels.

$1,000,000 Bridge on Florida East Coast

The Florida East Coast R. R. will build a bridge over St. John's river at Jacksonville, at an approximate cost of $1,000,000. W. G. Brown is engineer of road work, Florida East Coast R. R., St. Augustine, Fla.

Personals

E. E. Moberly, for seven years assistant division engineer on the Oregon Short Line on the Utah division, has been appointed division engineer of the Utah division to fill the vacancy caused by the death of Richard B. Reasoner. He has been with the Short Line since 1910, with the single break of his service between May, 1915, and June, 1916, when he was in government service. In 1910 he was appointed assistant division engineer at Salt Lake. In February, 1915, he was transferred to the Idaho division at Pocatello. In June, 1916, after returning from service he re-entered the O. S. L. service as assistant division engineer in the same division. In March, 1921, he was transferred to the Utah division, where he served until the time of his appointment as division engineer of that division.

R. H. Keays of Alaben, N. Y., was appointed chief engineer for the construction of the Moffat tunnel by the Moffat tunnel commission on July 13. Mr. Keays was one of the engineers for the famous McAdoo tunnel under the Hudson river from New York to Jersey City, where four tunnels were built for the Hudson & Manhattan Terminal Co. He also constructed the subway tunnel under Central Park for the Interboro Rapid Transit system in New York City. Other big projects on which he has been the chief engineer include the Wallkill tunnel for the Catskill aqueduct system of five miles in length, recently completed, and the Shandaken tunnels, 18 miles in length, to bring water from the Catskills to New York City. Mr. Keays was graduated from Cornell University in 1896.

Maj. L. D. Blauvelt has retired as chief engineer for the Moffat tunnel commission, but continues with the commission as a consultant.

I. M. Sommer & Co., consulting engineers, have removed their offices to 901 Bryant street, San Francisco.

G. W. Stickney has been appointed city engineer of Wheaton, Ill., to succeed L. J. Ruddock. Mr. Stickney, who is a graduate of the University of Maine, was on the engineering force of the Metropolitan Water Board of Boston for two years and on the New York State Barge Canal for 11 years. At the outbreak of the war he left the position of chief engineer of the Rivers and Lakes Commission of Illinois at Chicago to enter the service, being commissioned as captain and assigned to the command of Co. C, 26th engineers (water supply), with which outfit he served throughout the war with 11 months overseas. Since the war he has specialized in municipal and drainage work, being connected with Marr Green & Co. of Chicago, and for the past three years with Arthur L. Webster of Wheaton, Ill.

J. A. Lenecek has been appointed Chief Engineer of the Quito-Esmeraldas Ry. in Ecuador. Mr. Lenecek's latest position in the United States was in the engineering and construction department of the Erie. Previous to that he was engaged in engineering in Czecho-Slovakia, Bolivia and New York City. Mr. Lenecek was graduated from the Engineering University of Prague, Bohemia, in 1912.

E. G. Chenoweth, mechanical engineer of the Chicago, Rock Island & Pacific, with headquarters at Chicago, has been promoted to superintendent of the car department, with the same headquarters.

Obituaries

John N. Reynolds, for many years engaged in railroad publication work, died in San Diego, Calif., on July 10. Mr. Reynolds was born in England in 1846. In 1872 he became associated with Edward Vernon and others in preparing and publishing, in 1873 and 1874, the "American Railroad Manual of the United States and the Dominion." From 1874 to 1881 he was connected with Poor's Manual of Railroads. From 1875 to 1883 he did his first work in the business department of the Railroad Gazette. From 1881 to 1894 he was connected with the National Car and Locomotive Builder; and in 1881 he published the first directory of street railways of the United States, Canada, Mexico and South America. From 1894 to 1901 Mr. Reynolds was western representative of the Railroad Gazette. In May, 1901, he became vice president of the Railway Age, which position he held until May, 1908. On June 1, 1908, the Railroad Gazette, which was published in New York, and the Railway Age, which was published in Chicago, were consolidated, and Mr. Reynolds was appointed western manager of the consolidated paper. He continued to hold this position until January, 1913, when he retired, later moving from Chicago to San Diego, Cal., where he lived uitil the time of his death. Mr. Reynolds' active connection with railroad publications extended over a period of 40 years.

Joseph Gaston Legrand, bridge engineer of the Canadian National railways, western region, died in Winnipeg on July 2. Born in France in 1861, he came to Canada in 1891 and was appointed bridge engineer of the Grand Trunk Pacific in 1906 and came to reside in Winnipeg two years later. In 1920 he was promoted to the position he held at his death. During the intervening years he supervised the design and construction of bridges aggregating in value $12,000,000.

William Dailey, railroad contractor, died at his home in Montreal on July 9. He was born in Newton Upper Falls, Mass., in January, 1848, and came to Montreal in 1872. He was engaged on the aqueduct intake enlargement, the Lachine Canal, Wellington Basin, and later joined the Canadian Pacific Railway, with which company he spent several years as superintendent of construction. In 1890 he went to British Columbia, where he spent four years in charge of the new Westminster water works and the B. C. electric lines. Returning to Montreal, he became associated with the late W. G. Reid, and constructed the United Counties Railway and the Pearl Island Lines to Back River, Cartierville and Lachine. As manager of the Canadian Construction Co., Ltd., he directed the enlargement of the Farrans Point Canal, C. P. R. grade revision and T. & N. O. Ry. branches in Northern Ontario.

Capt. Robert Woolston Hunt, founder and president of the Robert W. Hunt company, consulting engineers, died at his home in Chicago on July 11, at the age of 84. Capt. Hunt was born on Dec. 9, 1838, in Fallsington, Buck county, Pa. He came to Chicago in 1888 and established the Bureau of Inspection, Tests and Consultation, which later became Robert W. Hunt & Co. In 1912 he was awarded the John Fritz medal for his contributions to the early development of the Bessemer steel process, and last June was given the Washington award by the various societies also in recognition of his achievement.

Buildings

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.
221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*
LEWIS S. LOUKE, *Vice-President and General Manager*
New York Office: 904 Longacre Bldg., 42d St. and Broadway
RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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Vol. LX. CHICAGO, ILL., AUGUST 22, 1923 No. 2

Building in Installments —A Neglected Means to a Proper End

The house of a man's (or a woman's) desires is all too frequently beyond his financial means. Still worse, the house that he hopes and actually expects to attain is almost as often beyond his reach, for it is easy to underrate both the difficulties and the cost of things with which we are unfamiliar, and the initiated in the building field are after all comparatively few. Also, as ever, the wish is father to the thought. And lastly these conditions apply to people pretty much regardless of their bank accounts.

It is strange that what would frequently be the least painful route of escape from the strait is one most seldom taken. Ordinarily the disappointed would-be house-holder sees only three courses open—to give up, for the time at least, the idea of owning his home, and to continue as a tenant in either house or apartment; to buy the best second hand home that he can find within his means; or to build a house substantially below his ideals.

Seldom does he think, or does his architect suggest, that it might be well to expend his present building fund on a portion of his ideal—modified as may be required to meet necessities—while he plans for a second or perhaps even a third installment to be made when his resources shall have increased.

Such planning will not suit every case. If a couple is getting on in years prolonged delay in completion may be the least desirable procedure; and the course would be positively foolish for people of any age who do not have definite and specific prospect of acquiring the funds for completion within a reasonable time. For thousands, however, who can fairly foresee increased resources the opportunities of this arrangement excell all others.

Unsightliness is not a necessary feature of the first installment by itself. Rare as the practice is, there are sufficient examples to prove this; but good results can be assured only through the services of competent architectural talent. Finally, although the beginning must be based

upon a complete general plan, that plan is not unchangeable, and cases will be rare where the conclusion can not be bettered through the added experience of the builders or the plan advantageously altered to meet changed conditions.

Appropriate Beauty in Industrial Plants

The accompanying view of a portion of the boiler works of Messrs Willans & Robinson, Ltd., at Queensferry, Flint, England, affords an excellent example of the simple and dignified beauty which may be given to an industrial building. It illustrates the slowly developing tendency to make of our work places something more than mere shelters for men and materials.

In commercial architecture beauty is considered necessary for business reasons, in addition to which there are in most cases, the pride and satisfaction of the builders as impelling motives. The industrial establishment, it is true, is usually seen by fewer and less critical eyes, but that fact can hardly exclude the elements of pride and satisfaction altogether. What may be the commercial value of good architecture in a factory or plant building we cannot say, but we believe that the value is real. The skilled workman may be counted upon to take more pride in the organization that employs him and more satisfaction in his work, if his employers have given him a good and creditable working place. He may not be able to analyze the architecture but he is the exception if he fails to sense real merit. Even the unskilled worker is not devoid of these perceptions; and furthermore if the thing is good, the word of those who know will find a ready acceptance.

Boiler Works, Queensferry, Flint, England, H. Bulkeley Creswell, F. R. I. B. A., Architect.

That appropriate beauty need not involve great cost is well illustrated by the Willans & Robinson Works. The case also indicates the advantage to be gained in the employment of an architect, and it is no detraction from the prestige of the engineer to say that only rarely is he qualified to handle truly architectural work. If he attempts architecture, his greatest danger is perhaps to depend upon applied ornament, and to forget that the prime requisite is a simple and straightforward treatment of structural facts.

We are indebted for the illustration to "The American Architect and The Architectural Review."

Halting Building Operations Because of Intolerable Costs

Editorial in The Chronicle, New York May 12.

According to the report of the Superintendent of the Bureau of Buildings, the plans for new construction filed in this city in the first four months of this year showed an increase over 1922 of 117 in number and a little over two millions in cost, but in April alone there was a falling-off of 20 in number and a little over a half-million in cost. Probably a decrease is not to be deemed of itself an unfavorable symptom, and certainly it should not be if it can be interpreted as due to a lightening of the feverish desire to crowd into great cities; but other reasons for it are more plainly at hand. What Mr. Stewart Browne, head of the United Real Estate Owners' Association, thinks about the effect of the temporary tax exemption which was prominent among the emergency laws and has been extended by the late session is of interest. The intended object of encouraging new construction, he says, has been attained to the extent of $322,621,385 in such construction, of which $244,170,325 is tax-exempt, but the other object of preventing a rise and inducing a fall in rents has been accomplished slightly "from the top downward but not from the bottom up." The higher prices have been cut somewhat, but the lower ones, which were most important in any view of the popular welfare, as an emergency objective, have not been touched. Some speculative builders may have been benefited, "but many have lost their shirts, as they can't sell." The doubts as to the real value and permanent expediency of coercive emergency measures have not been removed.

A halt in building, moreover, not only seems imminent but has begun. On Monday the trustees of Columbia University voted "temporarily" to suspend their ten-million building program, and the Thompson-Starrett Co. followed by deferring work on a large contract until conditions are stabilized; an orphan asylum similarly laid aside its plans for a new building; the telephone company's new 29-story central office and administration building which was to start next month and to cost over 11 millions, has been halted, "in the hope that the cost of building work may become more reasonable," and the total of projects which have recently been suspended has been variously estimated as from 21 to 50 millions; whether this kind of "buyers' strike" will bring a general halt of building is a matter of conjecture, awaiting "developments." A part of those developments is the return of a lot of striking stone cutters, to submit to "arbitration" (so-called) their demand for $2 more. As one builder puts it, the bricklayer is but one in a long procession; the painter, the plasterer, the plumber, the steam fitter, the tile-layer, and the rest all fall in, not only piling up costs, but so delaying work that buildings cannot be finished according to the time contract; as the "Chronicle" has pointed out repeatedly, all their mutiny spreads by example, and as the wage exacted rises the work done decreases. The blame continues to be passed around. The head of the Building Trades Council affirms that 63 ct. out of the dollar of construction cost go to the makers of building material and only 37 ct. go to labor, and he offers a pleasant challenge that he will be glad "to propose to the new Building Trades Council a prohibition of exorbitant wage scales" if the building material makers and the contractors will take similar action. What is an exorbitant wage scale is still left open to determination, presumably by those who receive it; on the other hand, the head of one concern offers, on behalf of building material dealers and brick retailers in particular, to open their books to any responsible inquiry and return any high profits discovered; he thinks his class of business men would gladly be limited for the rest of their lives to a guaranteed 5 per cent, and the news story appends the remark that outside his windows crews were then unloading brick from barges at a wage of $25 a day.

Particularly since the war period began, union labor has been proceeding upon the assumption that world trouble and public extremity meant labor opportunity; the forcibly closed shop, a periodical increase in wages, and a periodical decrease in production have been its three great objectives; plenty in money and scarcity in all else have been the union idea of union prosperity, and as for the prosperity and welfare of the strike-breakers and the other non-workers

outside of unions, unionism has not cared. Over and over we have pointed out that all this is economic falsehood, and have urged—with reiterated earnestness of late—that the time has come not only for a firm stand against re-inflation of wages, but for a serious and thoughtful effort by employers to counteract, by a presentation of economic truths, this long mis-teaching by union leaders. It is encouraging to note indications that a movement to this end, which doubtless has long been going on quietly, seems to be taking new force. At one group meeting, on Tuesday, of the session of the U. S. Chamber of Commerce, which has drawn a large attendance to the city in the past week, the head of the Bridgeport Brass Co., by talk and by use of series of colored blocks, showed how such topics as the function of the dollar in company with buying and selling, in wage relations and otherwise, is illustrated to the workers in his plant. He said this is done, in part, in response to a desire of the workers to know about such matters, and said the company is trying to make the worker understand his share in the finished article of product. Why not? Is not this suggestive and also encouraging? If economic truth is absolute, like the truths of mathematics, it must be assumed that the union member—who does not lose his natural mental ability merely by being deceived into surrendering it to union control—is capable of seeing things when they are shown him. To undo and combat falsehood, exhibit truth.

Is it not now time seriously to undertake and carry on that showing?

London to Have 600 Ft. Observation Tower.—London is soon to have an Eiffel Tower, built of concrete, 600 feet high, it is learned through press announcements. It will be erected at Wembley, the seat of the British Empire Exhibition. Although falling short of the height of the Woolworth Building in New York and the Eiffel Tower in Paris, the structure will give visitors to the exhibition a panoramic view of the country for miles.

The tower will be surmounted by a searchlight so powerful that it can be seen from France. Visitors will be taken up in a giant cage, which will rotate around the exterior at the rate of fourteen miles an hour.

[From The American Architect and The Architectural Review.]

Bankers and Builders

Editorial in The Building Review

Few people realize how great the responsibility banks must assume in connection with the building industry. Their work in financing large, business or semi-public buildings is taken for granted; but these constitute a small percentage of the total number of building operations, and in many cases the financing is privately managed.

On the other hand, the great bulk of building contracts is made up of small, individual housing propositions, and most of these must be financed. Building and loan and insurance companies take care of the comparatively small portion; it is upon the banks of the country that the responsibility mainly rests.

At present the banks have an abundance of money to invest, and it is not only a problem but a duty, to so lend their funds as to insure safe returns for the loan and a proper stimulation of business as developed in the building industry and its manifold ramifications.

Two things affect these objects most vitally; poor construction, resulting in early and undue depreciation, and the increase of costs, which naturally lowers the ultimate value of investment.

The work of bank appraisers therefore is now a most important and difficult one. Upon the impelling urge of keeping bank funds in circulation they must still assure themselves that each investment is safe and wise.

It is obviously to the permanent advantage of the building industry, including architects, labor, contractors, and manufacturers, and of the home-needing public, to co-operate with banks in these two fundamental matters; good construction and the reasonable control of costs. The temptation to seize a temporary opportunity to "get while the getting is good" is apt to blind men to the dangers affecting the future of the industry, like a fire-fly glittering over a marsh. And hurried, cheap construction, is the poorest kind of investment, for the owner as well as the financing interest.

Index Numbers of Wholesale Prices

An "index number" is really a percentage, and in the case of an "index price" shows the relative price level at different times. In the accompanying table the price level, or "index price," is 100 for the year 1913; and the indexes for other periods are those calculated by the U. S. Department of Labor.

The index for building materials is a weighted average of the principal building materials except steel.

	Farm products.	Foods.	Clothe and clothing.	Fuel and lighting.	Metal and metal products.	Building materials.	Chemicals and drugs.	House furnish'g g'ds.	Miscellaneous.	All commodities.
1913	100	100	100	100	100	100	100	100	100	100
January	98	99	99	100	107	101	100	100	106	100
October	103	102	101	102	97	98	100	101	98	101
1914	103	102	98	93	85	92	101	100	95	98
January	103	101	99	99	88	93	98	100	94	98
July	103	95	99	91	83	92	95	100	93	97
October	101	106	96	85	83	90	108	100	92	97
1915	104	105	98	86	99	94	124	100	95	101
January	104	106	94	87	82	88	108	99	99	98
July	104	104	96	81	106	94	130	100	94	100
October	106	102	101	94	105	98	151	100	93	102
1916	123	121	127	126	162	120	181	106	121	127
January	110	109	110	113	133	110	84	103	110	113
April	113	114	118	120	164	120	200	104	110	121
July	117	117	125	121	158	120	175	107	120	123
October	136	134	137	128	164	124	164	109	132	136
1917	190	167	175	169	231	157	202	125	148	177
January	152	149	158	171	188	138	173	118	149	153
April	184	164	164	164	230	155	186	121	153	173
July	196	169	181	176	292	168	205	125	153	188
October	207	180	185	153	207	156	231	139	142	183
1918	218	188	228	170	187	172	215	153	156	194
January	211	182	201	164	183	161	223	137	145	184
April	213	181	220	166	184	169	228	144	152	190
July	217	185	238	175	189	177	209	159	159	196
October	225	198	245	176	192	177	211	164	163	202
1919	231	207	253	181	162	201	169	184	175	206
January	224	203	220	178	175	176	181	167	166	199
April	230	205	205	177	153	169	160	167	160	199
July	241	210	262	181	160	209	167	183	177	212
October	227	205	291	189	162	229	173	194	187	211
1920	218	220	295	241	192	264	200	254	196	226
January	247	231	339	194	175	274	189	239	194	233
April	243	238	336	231	203	300	210	242	206	245
July	233	238	300	259	202	269	212	275	203	241
October	187	201	245	280	191	240	195	271	188	211
1921	124	144	180	199	129	165	136	195	128	147
January	143	162	196	247	153	192	153	217	154	170
February	133	151	188	225	147	180	149	217	147	160
March	127	151	183	212	140	173	143	216	139	155
April	117	144	176	205	138	167	135	216	130	148
May	118	139	173	200	138	165	134	209	126	145
June	114	137	172	191	133	163	133	196	125	142
July	119	141	172	186	124	160	129	180	123	141
August	123	146	171	184	117	156	129	179	119	142
September	124	142	178	181	116	156	131	179	118	141
October	124	140	180	189	116	159	131	180	118	142
November	121	139	180	197	114	163	129	178	119	141
December	120	136	180	199	113	158	127	178	121	140
1922	133	139	180	220	122	169	124	176	117	149
January	122	131	176	196	112	157	124	178	117	138
February	131	135	174	191	110	156	123	177	117	141
March	130	137	172	191	108	155	125	175	117	142
April	129	137	171	194	113	156	124	175	116	143
May	132	138	175	216	119	160	122	176	116	148
June	131	140	179	225	120	167	122	176	114	150
July	135	142	180	254	121	170	121	173	114	155
August	131	138	181	271	126	172	122	173	115	155
September	133	138	183	244	134	180	124	173	116	151
October	138	140	188	226	135	183	124	176	120	154
November	143	143	192	218	133	185	127	179	122	156
December	145	144	194	216	131	185	130	182	122	156
1923—										
January	143	141	196	218	133	188	131	184	124	156
February	142	141	199	212	139	192	132	184	126	157
March	143	143	201	206	149	198	135	185	127	159
April	141	144	205	200	154	204	136	187	126	159
May	139	144	201	190	152	202	134	187	125	156
June	138	142	198	186	148	194	131	187	123	153
July	135	141	193	183	145	190	128	187	121	151

Retail Prices of Building Materials

Average prices paid July 1, 1923, by contractors for building materials delivered on the job. These prices are secured through the Bureau of the Census and published monthly by the Division of Building and Housing of the Bureau of Standards, United States Department of Commerce.

The report as published by the Division of Building and Housing gives prices at 43 cities, 24 of which are included in the table herewith. Boston, New York, Philadelphia, Chicago and San Francisco are among the places not listed in the Bureau's report for July 1.

Item No.	Commodity. Size and condition.	Unit.	Fitchburg, Mass.	New London, Conn.	Poughkeepsie, N. Y.	Rochester, N. Y.	Buffalo, N. Y.	Baltimore, Md.	Columbia, S. C.	Savannah, Ga.	New Orleans, La.
1.	Common brick	1,000	$24.00	$32.00	$20.00	$17.75	$23.00	$20.00	$13.00	$17.50	$17.75
2.	Portland cement, excl. of containers	Bbl.	3.25	3.68	.....	3.35	3.03	3.25	4.00	3.85	3.40
3a.	Yellow pine, No. 1, dimension 2x4—16′, S1S1E	M	.....	60.00	.....	48.00	55.00	40.00	.....	30.00	43.00
3b.	Douglas fir, No. 1, dimension 2x4—16′, S1S1E	M	.....	55.00	49.00	56.00	55.00	.....	.....	.....	.....
3c.	N. Carolina pine, No. 1, dimension 2x4—16′, S1S1E	M	.....	45.00	.....	48.00	.....	.....	30.00	30.00	.....
4.	Common boards, No. 1, 1x6	M	55.00	.....	43.00	45.00	45.00	.....	30.00	.....	45.00
5a.	Y. P. flooring edge, grain "C," 1x4—10′—16′	M	115.00	135.00	130.00	130.00	72.00	.....	100.00	.....	.....
5b.	Douglas fir V. G., No. 2, 1x4—10′—16′	M	.....	.....	.....	.....	105.00	.....	.....	.....	.....
6a.	Red cedar shingles, extra clear, 16″, 5 to 2	100 sq. ft.	7.32	7.50	.....	6.25	6.00	11.20	.....	.....	.....
6b.	Cypress shingles, extra clear, 16″, 5 to 2	100 sq. ft.	.....	.....	.....	.....	.....	.....	.....	7.60	7.25
6c.	Composition shingles, crushed slate surfaced	100 sq. ft.	.....	7.25	6.50	.....	.....	6.00	6.85	6.50	.....
7.	Gypsum plaster board, ⅜″	1,000 sq. ft.	.....	50.00	47.50	30.00	45.00	32.50	.....	40.00	45.00
8.	Lime, HYD, com	Ton	24.00	26.00	22.00	20.00	16.00	17.50	22.50	22.50	22.00
9.	Building sand	Cu. Yd.	1.60	1.50	2.50	2.25	1.28	2.50	1.00	2.25	2.00
10.	Crushed stone, ¾″	Ton	3.25	.....	2.60	2.25	1.30	.....	3.70	5.25	.....
11.	Wire nails	Keg	4.10	.....	4.50	4.25	4.25	4.00	4.25	4.00	4.00
12.	Window glass, single A, 10″x12″	50 sq. ft.	4.80	.....	.....	4.20	4.20	4.00	.....	.....	4.34
13.	Hollow tile, 8″x12″x12″	Each	.30	.....	.24	.21	.22	.24	.19	.....	.22
14.	Cast iron soil pipe, 4″ E. H., 13 lbs. per ft	Ton	.....	.....	.....	83.93	90.55	74.34	.....	.....	95.39
15.	Steel pipe, 1″ galv	100 ft.	.....	.....	.....	10.25	10.00	10.10	11.80	9.46	9.92
16.	Reinforcement bars, ¾″ square	100 lbs.	4.00	.....	4.75	3.60	.....	3.50	4.60	5.00	3.75
17.	Structural steel, fab. 6″ I beams	100 lbs.	4.25	.....	5.25	4.50	.....	3.50	5.00	5.00	4.50
18.	White lead, dry	100 lbs.	13.50	.....	.....	13.05	14.50	.....	15.25	14.00	12.50
19.	Zinc oxide, Am. process lead free	100 lbs.	.....	.....	.....	.....	.....	.....	20.00	20.00	18.00
20.	Gypsum plaster, neat	Ton	.....	.....	.....	18.00	17.00	20.00	20.00	22.50	22.00
21.	Linseed oil, raw, in bbls	Gal.	1.16	.....	.....	1.23	1.31	1.13	1.45	1.35	1.17
22.	Roofing slate, No. 1 ribbon	100 sq. ft.	.....	.....	.....	.....	.....	.....	.....	.....	16.50
23.	Tar paper, roofing, 2-ply, 75 lbs. per roll of	100 sq. ft.	.....	.....	.....	.....	2.00	3.75	.....	1.90	2.50
24.	Rosin sized sheathing, 3-ply, 30 lbs. per roll of	500 sq. ft.	.....	.....	.....	1.50	1.50	1.45	.....	1.00	1.35

Item No.	Shreveport, La.	Pittsburgh, Pa.	Cleveland, Ohio	Dayton, Ohio	Detroit, Mich.	Bay City, Mich.	Waterloo, Iowa	Kansas City, Mo.	St. Louis Mo.	Grand Forks, N. D.	Sioux Falls, S. D.	San Antonio, Tex.	Tucson, Ariz.	Seattle, Wash.	Portland, Ore.
1.	.....	$18.00	$16.00	$18.00	$17.50	$15.00	$16.50	$16.50	$18.50	$18.00	$18.00	$17.50	$15.00	$20.00	$20.00
2.	3.60	3.10	3.48	3.60	.....	2.75	3.15	2.90	2.85	3.20	3.21	3.60	4.40	3.00	3.35
3a.	49.00	52.00	58.00	57.50	48.00	48.00	52.00	54.00	39.00	.....	.....	57.00	.....	.....	.....
3b.	.....	.....	.....	57.50	.....	.....	50.00	54.00	47.00	46.00	51.50	.....	65.00	23.00	24.00
3c.	.....	.....	.....	52.50	48.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4.	52.00	50.00	50.00	70.00	48.00	45.00	46.00	60.00	47.50	50.00	46.00	66.00	62.50	20.00	24.00
5a.	103.00	80.00	100.00	.....	.....	85.00	105.00	95.00	83.00	.....	.....	120.00	.....	.....	.....
5b.	.....	.....	.....	90.00	.....	.....	.....	85.00	.....	95.00	87.00	.....	100.00	.....	57.00
6a.	6.55	6.75	6.00	6.20	7.00	7.00	6.50	6.50	6.25	.....	5.80	6.80	.....	.....	5.00
6b.	7.00	.....	.....	6.50	.....	.....	.....	6.50	.....	.....	.....	.....	7.00	.....	.....
6c.	6.55	6.25	6.25	6.50	7.00	6.00	7.50	6.00	6.30	8.00	7.50	.....	.....	.....	.....
7.	45.00	37.50	32.00	50.00	30.00	40.00	36.00	30.00	42.00	55.00	32.00	.....	.....	35.00	38.50
8.	20.00	23.00	18.00	15.20	20.00	16.00	20.00	19.60	20.00	25.20	24.00	18.00	23.00	22.00	26.00
9.	2.00	2.50	2.50	2.00	2.75	2.50	1.75	.....	2.65	2.70	1.50	2.25	1.15	1.75	2.60
10.	5.40	6.00	3.50	2.00	2.35	3.75	3.00	2.00	.....	.....	.....	2.00	3.50	2.00	.....
11.	4.50	3.50	3.50	3.90	4.25	3.60	4.75	.....	.....	5.50	5.00	6.20	6.25	4.45	4.50
12.	5.10	5.95	.....	4.50	.....	5.00	5.25	4.50	4.50	.....	.....	4.50	.....	4.42	5.00
13.	.25	.21	.....	.21	.20	.18	.17	.17	.....	.....	.19	.25	.18	.....	.20
14.	97.00	.....	.....	110.88	.....	83.00	85.00	.....	.....	103.18	.....	120.00	.....	.....	112.42
15.	11.52	9.86	.....	10.57	.....	9.40	10.00	11.20	.....	.....	.....	11.12	15.00	12.50	16.50
16.	4.00	4.00	.....	.....	3.50	3.60	3.80	3.50	3.48	.....	.....	4.00	5.25	3.00	4.00
17.	6.00	3.25	.....	3.25	6.00	4.35	5.00	4.60	5.10	.....	.....	4.50	.....	5.00	9.00
18.	15.25	14.00	14.50	14.50	14.50	12.80	14.00	14.63	14.50	.....	.....	15.75	15.25	11.75	.....
19.	.....	17.00	.....	15.00	.....	18.00	19.00	.....	.....	.....	.....	16.00	.....	19.00	20.00
20.	24.00	22.00	.....	18.00	17.00	17.50	18.00	.....	18.00	22.00	17.00	24.00	21.00	21.00	24.00
21.	1.50	1.10	1.27	1.20	1.20	1.20	1.30	1.38	1.26	2.00	.....	1.40	1.46	1.35	1.24
22.	11.00	13.50	.....	15.00	.....	17.00	18.00	16.00	.....	.....	.....	18.00	.....	.....	30.00
23.	2.25	1.95	2.50	1.80	2.25	2.60	3.25	.....	.....	3.00	2.70	3.50	2.90	2.60	.....
24.	1.50	1.35	.90	.....	1.20	1.15	1.50	.....	1.23	1.80	1.50	2.25	1.75	1.20	1.80

Pittsburgh Steel and Iron Prices

The following data on prices and freight rates are taken from The Iron Age of Aug. 9:

Plates, sheared, tank quality, base, per lb	2.50c
Beams, channels, etc., base, per lb	2.50c
Soft steel bars, base, per lb	2.40c
Reinforcing steel bars, base, per lb	2.40c
Track spikes, 9/16 in. and larger, base, per 100 lbs	$3.15
Track spikes, ½ in. and smaller base, per 100 lbs	3.50-3.75
Spikes, boat and barge, base, per 100 lbs	3.50-3.75
Track bolts, ¾-in. and larger, base, per 100 lbs	4.00-4.25
Tie plates, per 100 lbs	2.55-2.60
Angle bars, base, per 100 lbs	2.75
Butt welded steel pipe, ¾-in.—Percentage discount—Black 60; galv.	48½
Butt welded steel pipe, 1 to 3 in.—Percentage discount—Black 62; galv.	50½
Lap welded steel pipe, 2½ to 6 in.—Percentage discount—Black 59; galv.	47½
Pig iron, No. 2X, Philadelphia, per gross ton	$25.76
O.h. rails, heavy, at mill, per gross ton	43.00

Freight Rates

All rail freight rates from Pittsburgh on domestic shipments of finished iron and steel products, in carload lots, to points named, per 100 lbs., are as follows:

Philadelphia	$0.32	St. Louis	0.43
Baltimore	0.31	Kansas City (pipe)	$0.705
New York	0.34	St. Paul	0.60
Boston	0.365	Omaha	0.735
Buffalo	0.265	Omaha (pipe)	0.705
Cleveland	0.215	Denver	1.27
Cleveland, Youngstown, comb.	0.19	Denver (pipe)	1.215
Detroit	0.29	Pacific Coast	1.34
Cincinnati	0.29	Pac. Coast, ship plates	1.20
Indianapolis	0.31	Birmingham	0.58
Chicago	0.34	Memphis	0.56
		Jacksonville, rail and water	0.415

Value of Haunching for Steel Beams

Editorial in The Canadian Engineer.

Results of great value to the structural engineer are recorded in the report of the committee of engineers appointed by the Steel Fabricators' Section of the Canadian Manufacturers' Association to investigate the value of beam haunching. Most engineers believe that structural steel beams encased or haunched with concrete are considerably reinforced or strengthened by such protective material. Specifications as they now exist, and in particular the building codes of cities and towns, do not, however, grant any consideration for the value of haunching. The beams are designed as if they were wholly unprotected. Believing that this method of design is wasteful, the fabricating companies engaged a special committee of engineers to conduct experimental investigation of the matter with results that are undoubtedly gratifying.

An interesting conclusion of the report is that to the effect that the ordinary theory of reinforced concrete can be applied to the combination of steel beams encased in concrete. Indeed, the usual hypothesis of no tension in the concrete which forms the basis of most practical reinforced concrete theory is much too severe in the case of haunched beams. Actual tests indicate that such beams will carry a total loading, that is dead and live load, 42 per cent greater than would be indicated by the application of the usual reinforced concrete theory. Placing the comparison on the basis of live load only, it is seen that the construction would carry 63 per cent more superimposed live load than the no-tension theory would permit. This advantage increases as the ratio of the live load to the total load increases.

The report of the committee is very properly cautious on certain matters which have yet to be elucidated by further experiment. The concrete used for encasing purposes in the present tests was of very high quality and it is not known if an equal or even proportionate benefit would accrue from the use of leaner mixes. The matter of bond strength between the concrete and the beam flanges is also still somewhat indefinite. In the tests reported, the bond resistance was found to be adequate for the development of high carrying capacity, but it cannot be said with certainty that the necessary bond strength would continue under heavy vibratory loads. Some investigation of the effect of these loads was made, but the committee admits that it was not carried on a sufficiently long time to give conclusive evidence. It is probable that since the bond strength is not a factor so far as dead loads are concerned, the addition of vibratory loads will not be able to break down the integrity of the combined construction; but for this we must await the evidence of further tests.

Period of Timber Shortage Is Faced by United States

Three Alleviating Measures Suggested by Department of Agriculture

Because this country's timber supply has been mined from the forest much as coal has been mined from the ground—without thought of replacement—America faces an inevitable timber shortage, foresters of the United States Department of Agriculture declare in a recent report on the timber situation printed for free distribution.

However, if timber crops were to be grown and intensive forestry methods observed on all forest land in the country—some 470,000,000 acres—the Nation's timber problem could be alleviated, it is stated.

"Three outstanding measures are necessary to bring about the growing of timber crops on forest lands," according to the report. "The first step is to stop unrestrained forest exploitation and the denuding which is a direct result of timber mining. The second step required is to reduce waste in the use of timber, and the third objective of paramount importance is to increase timber production to the full capacity of the land. Protection from fire, insects, and disease, of course, must go hand in hand with all reforestation projects.

"In short, with the utmost that can be done many years must pass before we can make our forests produce through growth as much timber as is now yearly taken from them, and a period of shortage is inescapable."

Some Features of the S. W. Straus Building Now Being Erected in Chicago

The new 32 story building now eing erected by S. W. Straus & Co., t the corner of Michigan Avenue and ackson Boulevard Chicago, at a cost f about $15,000,000 will be the argest structure on the Michigan ve. skyline, and is expected to be eady for occupancy by May 1, 1924.

Perspective of the New Straus Building, Graham, Anderson, Probst & White, Architects.

t will contain approximately 400,000 q. ft. of rentable office space in addition to the six floors to be occupied y the owners.

Architectural Features.—The main haft will be 22 stories high and will arry a 10 story tower centered on he Michigan avenue side. The plan s in the form of a hollow square, ith an inside court surrounded by offices. The exterior finish will be of Bedford stone with Florentine details up to the sixth floor, above which there will be a plain ashlar finish with perpendicular lines emphasized to accentuate the height of the building.

On the Michigan avenue side the center section of the building for a width of more than 80 feet, will be set back two or three feet from the line of the corner sections and will be thus carried up the entire height of the structure into the tower.

Graham, Anderson, Probst and White of Chicago are the architects.

Fabrication in Different Plants Hastens Work.—The steel work totals approximately 12,000 tons, and early in the spring of this year it was found that it would be impossible to have any one plant fabricate all of it if the building was to be completed on time. The Straus organization thereupon made divisional contracts with seven fabrication plants located in five different states, thus permitting the general contractors, Thompson-Starrett Company, to obtain the steel in time for completion according to schedule.

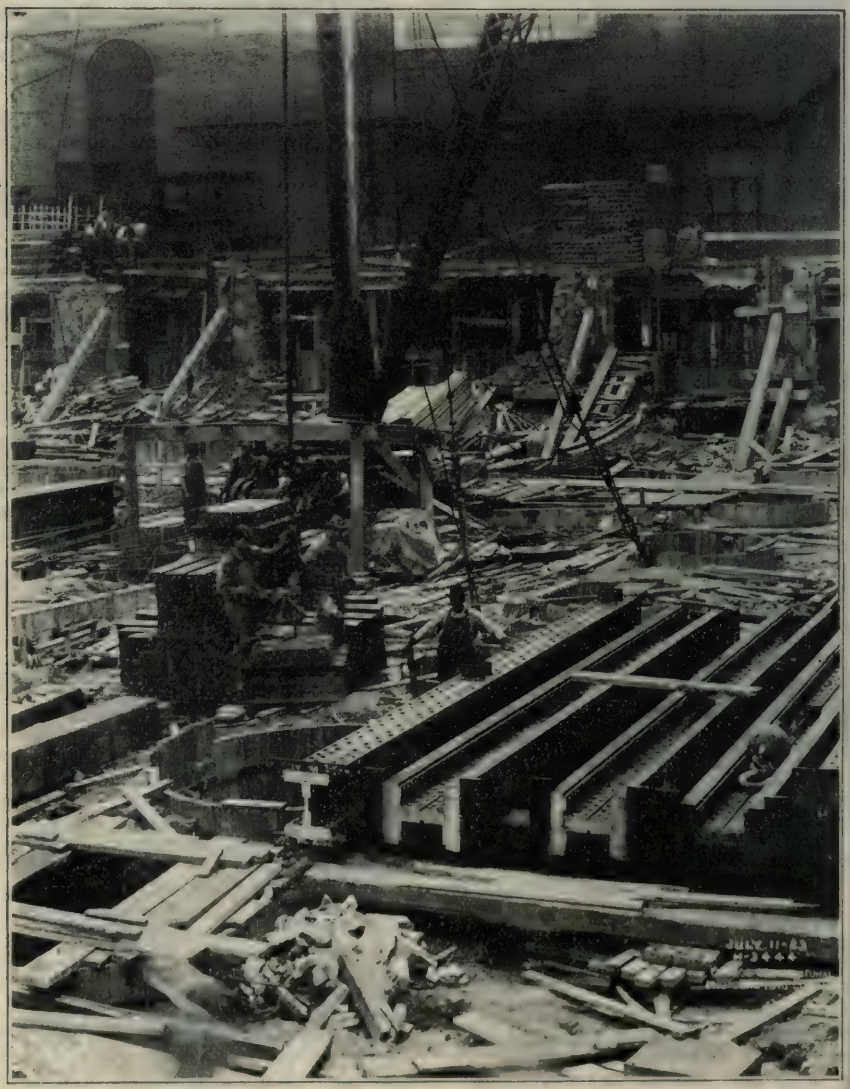
These divisional contracts were given on a tier rather than on a tonnage basis, so that the structural details could be completed without unnecessary delay.

The first tier steel is being fabricated by the Morava Construction Company of Chicago; the second tier by the Vanderkloot Steel Works of Chicago. The third tier columns, spandrels and interior girders are being made by the Minneapolis Steel and Machinery Co., of Minneapolis; the girders in the third tier by the Lakeside Bridge and Steel Co., of North Milwaukee, Wisconsin; the floor beams in the third tier by the Morava Construction Co., and the two large girders over the main entrance by the Phoenix Bridge Co., of Phoenixville, Pennsylvania. The fourth tier columns are being fabricated by the Kansas City Structural Steel Co., of Kansas City, Missouri; the floor beams by Morava, and the court spandrel girders by the Kansas City Structural Steel Co. The contract for the fifth tier columns is being handled by the Vanderkloot Steel Works; the sixth and seventh tiers by the Hansel-

Elcock Co., of Chicago. Work for the eighth, ninth, tenth, eleventh and twelfth tiers is being done by the Morava Company. The fabrication work for the ten story tower is being handled by the Vanderkloot Steel Works. Each tier embraces two floors with the exception of the third tier which includes three floors.

The steel for the new building is being purchased from the Inland Steel Co., of Chicago. Supplies and materials for actual construction are being purchased on sub-contract by the Thompson-Starrett Co.

Underpinning and Foundations.—The foundations are carried to bed rock 115 ft. below street level. This is done by the open well method which has long been used and is pretty well standardized in Chicago. Two of the 78 footing wells of the



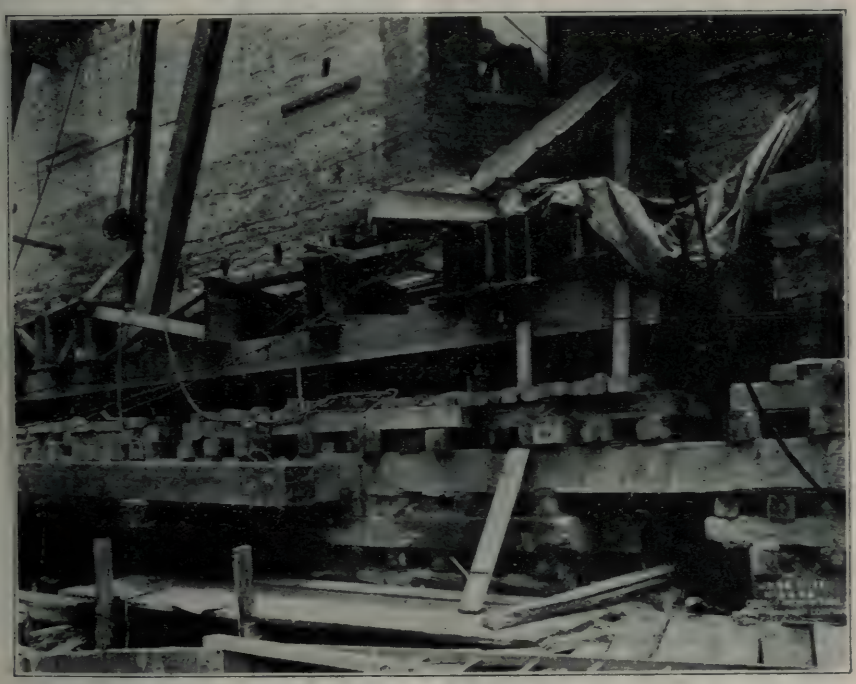
Foundation Work—Columns Lying on the Ground to Right of One of the Wells Into Which Two Men Are Being Lowered on Steel Work for the Footing.

Straus Building are, however, remarkable as being the largest ever sunk in Chicago. Their diameter is 11 ft. 9 in.

Concrete is placed in each well to a height of 62 ft. above bed rock, and on this rests a steel grillage and the first tier columns 30 ft. long.

Adjoining the Straus Building site on the south is the 7 story Leschin Building, and a contract with its owners requires the owners of the Straus Building to provide footings between the two properties for a double line wall. The work in this case is difficult because of the 92 ft. of soft clay soil. While these footings are being constructed the Leschin wall is supported by underpinning with jacks every two feet.

Protective underpinning is also being carried on under the Illinois Theatre across the alley to the west, although the problem there has not presented the difficulties met with on the underpinning to the south.



Underpinning of the Leschin Wall.

The Protection of Buildings Against Lightning

The Sectional Committee on Protection Against Lightning organized jointly by the Bureau of Standards and the American Institute of Electrical Engineers, has been active in the preparation of a tentative standard for the protection of buildings and other property against lightning. A joint meeting of Group I of the Sectional Committee in charge of the work, together with the National Fire Protection Association's Committee on the same subject, was held in Chicago on May 7 so as to secure the view of the various members. Copies of the tentative standard have also been circulated generally for comment by those interested, and the final draft is now being worked out.

There is a great difference between a lighting fixture that will merely light and one that supplements the decorative detail of the room as well.

Effect of Accelerators in Concrete

Results of Laboratory Tests on Accelerators of Calcium Chloride Type Given in Committee Report Presented at 26th Annual Meeting of the American Society for Testing Materials

During the past two years a subcommittee of Committee C-9, of which A. T. Goldbeck is chairman, and J. C. Pearson, secretary, has conducted a co-operative series of tests on accelerators of the calcium chloride type. The results are set forth in a report presented at the 1923 meeting of the American Society for Testing Materials. The reports follows.

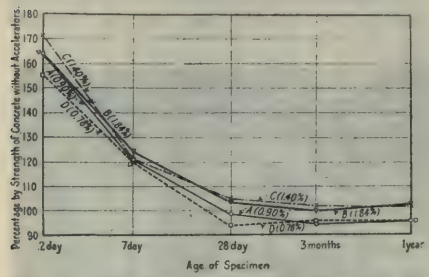


Fig. 1. Relative Compressive Strength of 1:2:4 Concrete Containing Accelerators.

Each curve is the average of the results obtained with the acceleration indicated thereon by letter. The figures in parenthesis indicate roughly the average percentage of anhydrous chloride by weight of cement.

In the fall of 1920, Sub-Committee XI of Committee C-9 was created to study and report on accelerators for concrete. Early in 1921 the sub-committee proposed a program involving a limited series of tests by a number of laboratories on accelerators of the calcium chloride type. This program was approved by the general committee, and was in brief as follows:

The Test Program.—A number of laboratories were to be requested to carry out a series of compression tests on 1:2:4 concrete and 1:2½ mortar (volume proportions) using local materials and three or more commercial accelerators. The tests were to be made in such manner as to afford a direct comparison of the strengths of the mixtures with and without the accelerators at the ages of 2 days, 7 days, 28 days, 3 months and 1 year. The purpose of the tests was primarily to determine whether the effects of any or all of the accelerators were, or were not, considerable after the 28-day period; incidentally, it was hoped that the tests would indicate whether or not different brands of cement respond in the same general manner to a given accelerator, also whether the different accelerators have different effects on a given brand of cement, and if so, whether such differences could be accounted for by differences in calcium chloride content.

Co-operating Laboratories.— The laboratories which offered to carry out the series of tests as outlined were as follows:

U. S. Bureau of Standards, Washington, D. C.; U. S. Bureau of Standards, Denver, Colo.; Lehigh Portland Cement Co., Allentown, Pa.; City of Philadelphia, Bureau of Surveys, Philadelphia, Pa.; Lewis Institute, Chicago, Ill.; Hydro-Electric Power Commission, Toronto, Ont., Canada; Pennsylvania State Highway Commission, Harrisburg, Pa.; Delaware State Highway Commission, Dover, Del.; New Jersey State Highway Commission, Trenton, N. J.

Unfortunately, not all of these laboratories followed the procedure outlined by the sub-committee, so that direct comparisons of results are somewhat less numerous than the list would indicate. For example, the Lewis Institute undertook a very much more extensive program than that contemplated by the committee, but the work was not laid out in such manner as to include the mixes specified in the committee's program. Detailed data from the Lewis Institute

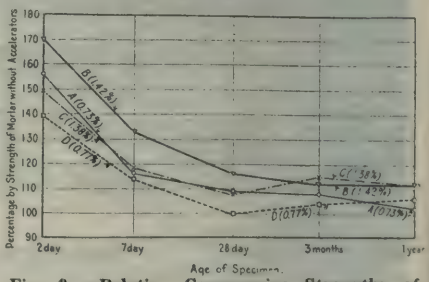


Fig. 2. Relative Compressive Strengths of 1:2½ Mortar Containing Accelerators.

Each curve is the average of the results obtained with the accelerator indicated thereon by letter. The figures in parentheses indicate roughly the average percentage of anhydrous chloride by weight of cement.

are, therefore, omitted from this report, but reference is made to the Lewis Institute results in the general conclusions reached by the sub-committee. Some of the laboratories failed to submit all their results in time to be incorporated in this report, and others departed in various ways from the fixed program. Nevertheless, in the attempt at a general analysis of results, all data that could be used are included.

Materials.—The accelerators were obtained from several different sources, arrangements being made with the manufacturers or distributors to contribute these materials in the quantities required by the co-operating laboratories. A condition was imposed by the committee that those manufacturers who cared to have their materials included in the test should furnish full information in regard to to the nature and composition of the accelerators. The result of this was to eliminate one or two materials that the committee had contemplated using, and to reduce the number of ac-

Table I.—Summary of Accelerator Tests

Age	Laboratory	1:2:4 Concrete A	B	C	D	1:2½ Mortar A	B	C	D
	Delaware	155	173	168	137	145	156	155	141
	Denver	141	135	157	.....	103	108	110	.....
	Lehigh B[1]	.....	149	107	115	.....	162	112	125
	Lehigh D[2]	.....	127	141	106	.....	.....	.....	.....
2 days	Pennsylvania	.....	114	147	165	.....	153	169	128
	Philadelphia	171	207	215	176	141	168	175	152
	Washington	150	170	172	127	127	127	129	109
	New Jersey	211	279	274	214	187	211	191	189
	Ontario	159	119	154	172	236	271	148	129
	Average	164	164	171	155	156	170	149	139
	Delaware	128	145	144	126	109	125	121	118
	Denver	118	107	126	.....	88	107	106	.....
	Lehigh B	.....	119	98	139	.....	136	103	123
	Lehigh D	.....	89	105	89	.....	.....	.....	.....
7 days	Pennsylvania	.....	129	112	128	.....	112	117	99
	Philadelphia	117	138	136	114	123	132	125	118
	Washington	113	122	122	101	105	107	110	91
	New Jersey	132	158	143	128	130	146	137	140
	Ontario	113	108	107	134	128	194	126	108
	Average	120	124	121	120	116	133	118	114
	Delaware	98	104	113[3]	92	111	117	113	106
	Denver	104	118	118	.....	99	106	97	.....
	Lehigh B	.....	111	92	121	.....	117	115	116
	Lehigh D	.....	91	92	74	.....	.....	.....	.....
8 days	Pennsylvania	.....	113	121	101	.....	101	111	90
	Philadelphia	103	100	107	96	104	105	109	97
	Washington	96	105	111	86	104	111	109	96
	New Jersey	.....	.....	.....	.....	.....	.....	.....	.....
	Ontario	95	91	88	86	125	152	99	95
	Average	99	104	105	94	109	116	108	100
	Delaware	93[3]	97[3]	93[3]	86	89	98	108	80
	Denver	86	100	102	.....	97	93	92	.....
	Lehigh B	.....	115	100	113	.....	107	118	106
	Lehigh D	.....	82	87	74	.....	.....	.....	.....
months	Pennsylvania	.....	98	116	105	.....	103	98	92
	Philadelphia	117	117	118	112	120	126	145	126
	Washington	90	103	101	85	103	120	121	98
	New Jersey	.....	.....	.....	.....	.....	.....	.....	.....
	Ontario	91	91	89	87	129	138	121	112
	Average	95	100	102	96	108	112	115	104
	Delaware	95	110	118	102	93	105	102	105
	Denver	107	113	121	.....	76	94	83	.....
	Lehigh B	.....	87	78	83	.....	131	132	125
	Lehigh D	.....	109	82	83	.....	.....	.....	.....
year	Pennsylvania	.....	102	114	101	.....	95	111	100
	Philadelphia	104	112	106	115	123	115	131	121
	Washington	84	104	105	87	102	122	126	97
	New Jersey	.....	.....	.....	.....	.....	.....	.....	.....
	Ontario	81	84	88	102	118	125	98	89
	Average	96	103	102	106	102	112	112	106

[1]High-Silica Cement. [2]Low-Silica Cement.
[3]Some of these specimens exceeded the capacity of the machine.

celerators used throughout the tests to three. In all cases, however, one or more of the accelerators were used in different proportions, and in a few cases, accelerators from other sources were included.

It is obviously impossible in this report to list all the materials and tests thereof that were submitted with the data from the co-operating laboratories. Local aggregates of established quality were used in all cases, and as it happened, each laboratory used a different brand of cement. Besides a number of brands used in the Lewis Institute investigation, the following were included in the tests: Tidewater, Ideal, Lehigh, Pennsylvania, Pyramid, Whitehall and Bath.

General Instructions for Carrying Out the Tests.—Bearing in mind the main purpose of the tests, the subcommittee laid down only general instructions that would insure in so far as possible comparable procedure in the several laboratories and elimination of extraneous variables in any one laboratory. In general, the methods followed were those outlined in the Tentative Methods of Making Compression Tests of Concrete. Definite instructions based on manufacturers' recommendations were given for the preparation and use of the accelerators. The desired consistency and method of curing were indicated, but greater importance was placed on uniformity of conditions in any one laboratory than an absolute agreement among the several laboratories.

Summary of Results.—The results of the tests carried out by the co-operating laboratories and included in the general program are summarized in Table I. The absolute strengths are not given, but the figures indicate the relative strengths obtained at the different ages from the mixtures containing the accelerators, on the basis of 100 for the strength of the mixtures without accelerators.

The accelerators are designated in the table by the letters A. B, C and D. A and B refer to a commercial calcium chloride and are, respectively, solutions of 2 per cent and 4 per cent of the chloride as marketed, in the mixing water. C and D and proprietary materials comparing very roughly with B and A, respectively, in content of anhydrous calcium chloride.

The averages of the results given in Table I are plotted in Figs. 1 and 2, the former showing the effects of the accelerators on 1:2:4 concrete at the different ages, and the latter the corresponding effects on 1:2½ mortars.

As in Table I, the letters on the curves indicate the different accelerators and the figures in parentheses indicate roughly the *average* amounts of anhydrous chloride by weight of cement.

Discussion of Results.—The individual results as given in Table I show a very wide range and numerous inconsistencies. However, the average of all the results seem to establish the general conclusion that the beneficial effects of the accelerators are confined to the early ages under the prescribed laboratory conditions of curing and storage. Under these conditions the effect of the calcium chloride is to accelerate the hydration of the cement markedly during the first few days, but the resulting gain in strength largely disappears at the 28-day period and thereafter. The results of the Lewis Institute investigation substantiate this general conclusion. It will be noted, however, that the relative strengths of the modtars containing the accelerators after the 28-day period are slightly higher than those of the concretes and of the plain mortars for the later periods.

The marked differences in the results reported from the different laboratories indicate that different brands of cement respond in different degree to the accelerators but the inconsistencies in the results are sufficiently numerous to warn against any positive conclusions in this respect. The Lewis Institute investigation seems to establish this fact with certainty, and affords comparative data on a limited number of cements. While the action of calcium chloride on cement is not well understood, it is to be presumed that it is effective in promoting the hydration of one or more of the main constituents of the cement, and as these constituents are known to exist in different proportions in different cements, and even in different lots of the same brand of cement, it should be anticipated that different brands or lots would respond in different degree to the action of accelerators.

Comparative Effect of Different Accelerators.—In regard to the comparative effects of different accelerators, the data obtained in this investigation

suggest that the acceleration of hardening is probably dependent either upon the proportion of calcium chloride to the cement, or the concentration of calcium chloride in the gaging liquid. A considerable amount of time was therefore given to an analysis of the complete data from three of the co-operating laboratories, in which the relative strengths were plotted against the two factors: ratio of anhydrous chloride to cement, and concentration of anhydrous chloride in the gaging water. Curves of the same type were obtained in both cases but the wide range of individual results made it impossible to determine to which of these two factors the relative strengths were more closely related. It would undoubtedly be of interest to know more than we do at the present time regarding the relation of quantity or strength of calcium chloride to the acceleration of the hardening of concrete, and in fact to know more about the action of calcium chloride on cement, but this information must come from a more comprehensive and carefully planned investigation. So far as the data from these tests can be interpreted, the different accelerators produce effects which are mainly dependent upon their calcium chloride content. It is not to be inferred, however, that the acceleration of hardening is directly proportional to quantity or concentration of calcium chloride, for while the range of calcium chloride content in the accelerators used in the sub-committee's tests was not sufficiently great to indicate a maximum effect upon the strength of concrete, the Lewis Institute investigation showed that such a maximum exists, on the average not much beyond the maximum concentrations employed in these tests.

In conclusion, the sub-committee would recommend that if further data were to be sought on the effects of accelerators, perhaps the information of greatest practical value would be forthcoming from their effects upon mortar or concrete at temperatures in the neighborhood of the freezing point, and also under conditions where wet curing is impracticable. Results obtained in the Lewis Institute investigation indicate that calcium chloride is more effective under dry curing than under moist curing, and this is substantiated by data from other sources. It is important also that definite knowledge be obtained regarding the effect of accelerators upon the steel in reinforced concrete. Such meager information as is available at the present time indicates that when steel is completely embedded in dense concrete, the danger of serious corrosion from the chloride is negligible, but it is doubtful whether this statement applies to all types of reinforced concrete construction under all conditions of exposure.

Cement Making Pictured in New Film

Much of the unusual equipment involved in making cement is interestingly illustrated in a two reel moving picture called "The Story of the Manufacture of Portland Cement," just released for general showing. Starting with views of one of the large plants in which the country's cement is made, the film pictures in a non-technical way the essential steps in transforming thousands of tons of raw materials into Portland cement. Scenes taken at a number of plants are included. From the moment that a great blast breaks loose a cliff of limestone in the quarry to the time when the finished cement goes into storage in big concrete bins, the process of manufacture is almost entirely mechanical—otherwise present day outputs would be impossible. In addition to straight photography, animated drawings have been inserted to make clear what occurs inside the grinding mills, what goes on within the white-hot interior of the huge kilns, and how the cement sacks, suspended upside down, are filled after they have been tied. This film can be secured without charge by interested organizations through any office of the Portland Cement Association, or from Association headquarters at 111 W. Washington St., Chicago.

Zoning for Providence.—The adoption by the City Council on June 6 of a zoning ordinance assures for Providence proper supervision covering such points as height, area and use of buildings. The ordinance was examined closely by hundreds of citizens whose property is affected, and yet no opposition to the restriction developed. The committee in charge had the benefit of expert knowledge on zoning, and before laying out the districts every part of the city was inspected. The municipal government asks that citizens cooperate with the Inspector of Buildings and the Board of Review in carrying out the provisions of the zoning ordinance.

Construction Costs of Jail for St. Louis County, Minn.

By W. C. BROCKWAY
Assoc. M., Am. Soc. C. E., 213 Torrey Building, Duluth, Minnesota

The unit cost of the county jail now under construction at Duluth, Minnesota, will be more than $1.45 per cubic foot. The total cost on completion of work will be about $620,000. The building is 132 feet by 47 feet in plan, and about 67 feet in height, of reinforced concrete construction, with granite facing.

In the basement room is provided for the following: kitchen, storeroom, garage, storage, incline to tunnel, elevator machinery. A tunnel has been constructed, connecting the courthouse with the jail. This is about 125 feet long, and is for the purpose of taking prisoners from one building to the other.

On the first floor, provision is made for a laundry, warden's room, offices, six wards, probate and examination room, nurses' duty room, matron's room, kitchen, elevators, and small storerooms.

The second and third floors each consist of 24 cells in one block, and 8 cells in another. The cell blocks, each with two rows of cells with a utility corridor between, are located through the longitudinal center of the building. On the outside of the cell blocks are the prisoners' corridors, and outside of these are the guards' corridors, next to the exterior wall. The two cell blocks are separated by a central corridor.

On the fourth floor is one cell block of 24 cells, laid out with cells in two rows with a light court between. A prisoners' corridor is on each side of the cell block next to the exterior walls. Juvenile and women's recreation rooms are provided. Four isolation cells and a school room are also on this floor.

This building is being constructed to harmonize with the present courthouse, the proposed city hall, and the proposed postoffice, all of which were originally laid out in a group, known as the "Burnham Plan."

The following contracts have been let up to July first:

General Construction	$429,700
Tool Proof Steel for Cells	24,000
Additional Contract for Clark Granite	11,535
Contract for substitution of granite for architectural terra cotta	26,500
Additional excavation in basement	7,960
Heating, ventilating and plumbing	74,929
Electrical Work	13,248
Power Plant Extensions, Court House, including switch board, engine and steam equipment	29,089
Total to date	$616,961

The Contractor has informally stated that $200,000 is the approximate figure incident to jail construction.

Omitting the item of tool proof steel, the cost per cubic foot of the contracts already let is $1.42, taking the size of the building at 416,000 cubic feet.

The building is to be heated and lighted from the plants in the Courthouse. The maximum daily demand estimated for the Courthouse in 1924 is 142 K. W. The estimated jail load is 100 K. W., making the total 252 K. W. The jail has minute and extensive electrical equipment.

The County Commissioners on the jail committee are: Alex Fraser, Walter Swanstrom, W. E. Fay, D. M. McKenzie.

John Q. Adams, engineer of the courthouse building, was later appointed to this committee. Holstead & Sullivan, Duluth, Minn., are the architects.

Jacobson Brothers, contractors, were awarded the contract for general construction. D. R. Black & Company were awarded the contract for heating, ventilating and plumbing. The Commercial Electric Company received the contract for the switchboard, and John Smith for the engine and steam equipment.

City Planning Courses at Harvard.—By action of the faculty, the Harvard School of Landscape Architecture is empowered to announce a full course in city planning leading to a master's degree,—an M. L. A. in the field of city planning. This will be one of two options offered to students entering the school in September, 1923, the other option fitting a man for private problems of landscape architecture, especially estates and gardens, and for designing parks and pleasure grounds.

Proposed Loading for Highway Bridges

An Analysis of Common Practice as to Assumed Loads, and a Comparison With Results Under More Accurate Assumptions, Showing That Older Methods Are Unsatisfactory for Modern Conditions

A Paper Published in Proceedings of the American Society of Civil Engineers for August, and to be Presented to the Society Sept. 5, 1923

By HAROLD D. HUSSEY, ESQ.
Asst. Engineer, American Bridge Co., New York City

This paper is a discussion of highway bridge loads with a proposed new loading system for use in highway bridge design.

During 1921, the writer was engaged in developing a set of designs of highway bridges suitable to carry heavy modern traffic. The study of the live load to be used in these designs is the basis of this paper.

Development.—It was decided to confine this study to a load of 20-ton trucks. State Specifications of 20-ton truck loads were studied, and were found mainly to specify a sliding scale of uniform loads for the trusses and girders, but for the floor system and hangers of the trusses, the actual truck loads were to be used. A common uniform load for the trusses was 100 lb. per sq. ft. for spans up to 100 ft., 80 lb. per sq. ft. for spans of more than 200 ft., and proportionate loads for intermediate spans.

It was felt that, although this loading may be satisfactory for long spans, the constant load of 100 lb. per sq. ft. for all spans up to 100 ft. was hardly sufficient when compared with the 20-ton truck on the floor. In order to examine this point thoroughly the equivalent uniform loads, for both moment and shear, for a 20-ton truck, were computed and plotted as on Fig. 1. This diagram shows very high values of equivalent uniform loads for short spans, which diminish as the span increases, until they equal 100 lb. per sq. ft. at spans between 70 and 80 ft. Further study developed the results in Table 1, which gives the span lengths at which a uniform load of 100 lb. per sq. ft., covering the width of a truck, will cause the same shear and moment at various points as a single 20-ton truck.

Thus, a single 20-ton truck standing in the center of a bridge will give a greater shear at the center than a uniform load of 100 lb. per sq. ft., over a 10-ft. width for all spans up to 152 ft., or, for all spans up to 152 ft., two 20-ton truck, standing side by side in the center of a span, with a 20-ft. roadway, will give a greater shear at the center than 100 lb. per sq. ft. over the entire width of roadway.

Table 1.—A Comparison of the 20-Ton Truck of Fig. 1 With 100 Lb. Per Sq. Ft. on a 10-Ft. Width.

Point on Span	Span length, in feet, for equal shears.	Point on span.	Span length, in feet, for equal moments.
End	76	.....	....
9/10	84	¼ point	75
8/10	95	Center	72
7/10	109	.....	....
6/10	127	.....	....
5/10 (center)	152	.....	....
4/10 (for counter shears)	190	.....	....

The equivalent uniform load value for a single truck decreases rapidly as the span increases, as shown by Fig. 1. In order to illustrate the effect of several trucks on the bridge at the same time, computations were made of maximum moment and shear for a line of trucks 50 ft., center to center of adjacent trucks, any number of trucks being used and placed in the most unfavorable position on the spans, and these results were plotted on Fig. 1. The curves for this load coincide with those for the single truck load to a point at which the additional trucks add their load, where they leave the curves for the single truck and tend to flatten out at about 80 lb. per sq. ft. The reason for this is that 80 lb. is the square-foot equivalent load for a 20-ton truck over a width of 10 ft. and a length of 50 ft. These curves (Fig. 1) show a large difference in value between end shear and maximum

moment for any span, whereas the difference between the maximum moment and shear at any intermediate point is even greater. This is true of any system of concentrated loads that are spaced far apart. It is evident, therefore, that a single uniform load cannot equal any multiple truck loading for all moments and shears in a span—either the web members will be over-stressed, or the chord members will be under-stressed, both of which result in an unbalanced and uneconomical design.

To correct this serious defect of the old uniform load several different loading systems were tried. An attempt was made to modify the uniform load system by adopting a heavy load—comparable to the equivalent uniform load for a single truck—for a span of 35 ft., decreasing in a broken line which would approximate as closely as possible the multiple-truck load. This type of loading was considered an improvement over the old uniform loading.

A study was made of a loading consisting of a fixed amount per linear foot for each line of traffic accommodated on a bridge, using a sliding scale of loads similar to the modified uniform load just mentioned. Considered on the basis of pounds per square foot of roadway, this type of loading has little practical difference from the modified uniform load system.

In both the preceding systems, an attempt was made by means of a system of uniform loads to match as closely as possible the equivalent uniform loads of the actual trucks. In doing so, it was necessary to assign a single uniform load for use in computing both shear and moments, which, as previously demonstrated, results in both an unbalanced and an uneconomical design.

It became more and more evident

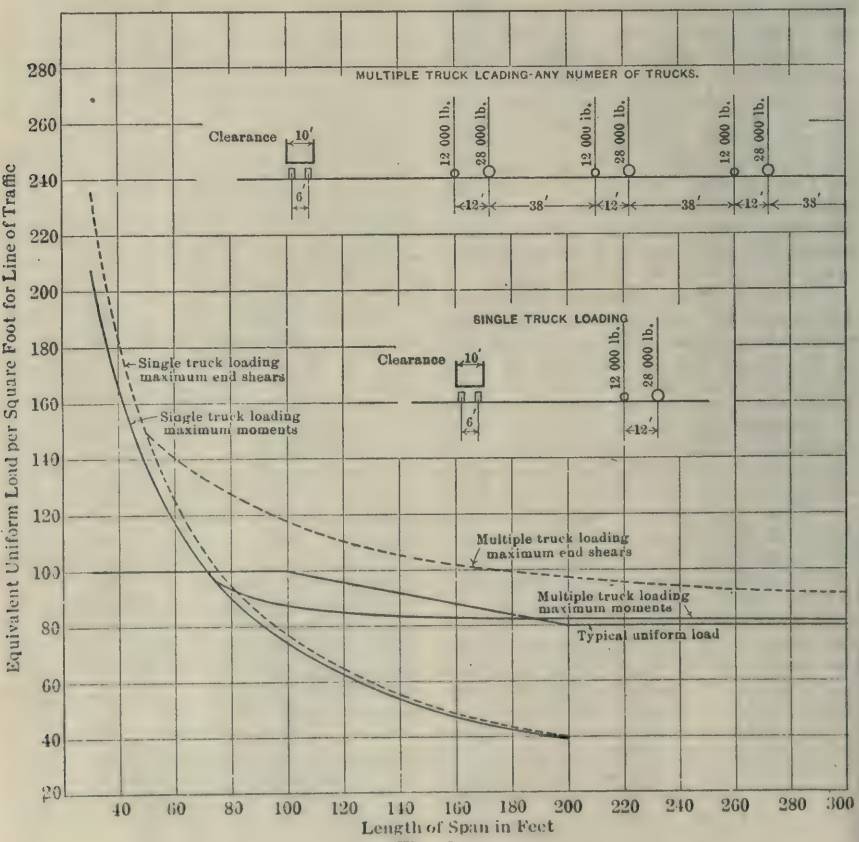


Fig. 1.

that, in order to obtain the most uniform results, the actual wheel loads of the trucks themselves should be used in the loading system, and it was finally decided to do so. A system of loads in which the truck concentrations are followed by a uniform load was considered as being the most satisfactory form, and a system of

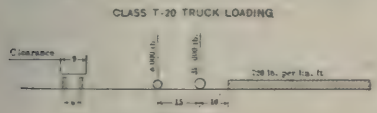


Fig. 2.

this kind was used in the immediate work at hand.

Since the work was completed, further study of highway loadings has been made, and valuable criticism has been received, to the end that some changes have been made in the loading as originally developed, without altering its character. The proposed loading is shown in Fig. 2. This is a loading for 20-ton trucks and is called "Class T-20 Truck Loading." It is based on a line of traffic 9 ft. wide, as shown. A bridge will accommodate as many of these line of traffic as the width of roadway will permit.

Some explanation of this loading is necessary. The width of 9 ft. is based on the practice of highway engineers of building paved roads to accommodate two lines of traffic with a width of 18 ft. Two trucks will readily pass on a bridge with an 18-ft. roadway.

The uniform load following the truck concentrations is equivalent to 80 lb. per sq. ft., which seems sufficient from a study of Figs. 1 and 3. A load of 80 lb. per sq. ft. has been recommended by the Committee on Iron and Steel Structures of the American Railway Engineering Association in its proposed General

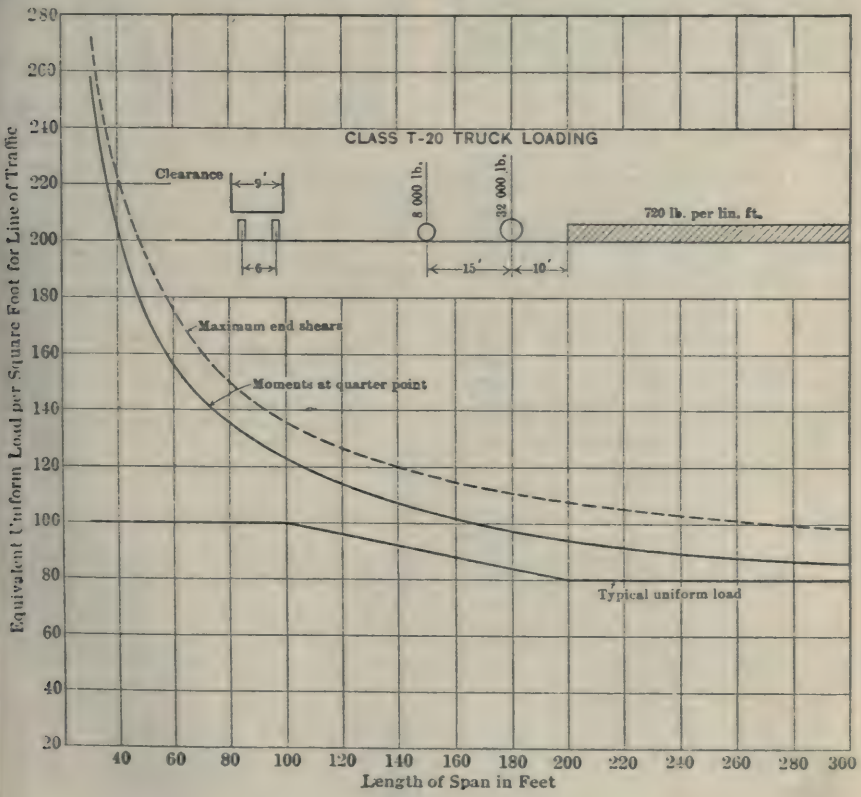


Fig. 3.

Specifications for Steel Highway Bridges.*

The concentrations used are for a single truck. Although there are many 20-ton trucks on the roads, the tendency in State control of traffic is to limit the maximum truck load to somewhat less than 20 tons, which means that the major part of traffic will be made up of trucks of less than 20 tons. If the major part of the traffic were of 20-ton trucks, it would be necessary to adopt a loading that would satisfy this condition, and either use two or more trucks followed by a uniform load, or one truck followed by a very heavy uniform load. It was not considered necessary to meet this condition, however, and the present loading is the normal requirements of present-day traffic, and the probable requirements of future traffic.

Objections might perhaps be raised to any departure from a simple uniform load for highway bridges on the ground of difficulty of application. There should be no objections for that reason if another type of load stands analysis better than the uniform load. The different loading systems should be rated on their merits. However, for actual use, it is proposed to compile shear and moment tables for a line of traffic 9 ft. wide for a T-10 loading, for various panel and span lengths, similar to tables that have been made for the railroad loadings, E-10 and M-10, as presented by the Special Committee on Specifications for Bridge Design and Construction of the Society.† The tabulated moments and shears could then be multiplied by 2 to obtain values for a T-20 loading, or by a simple factor to obtain such values for any other desired T-loading, for a traffic lane 9 ft. wide. This will simplify the application of this loading system so that it will be as easy to use as the uniform loading system. It is regretted that lack of time prevents the writer from submitting complete moment and shear tables with this paper.

For the application of this system

*Bulletin 252, Am. Ry. Eng. Assoc., December, 1922.

†Proceedings, Am. Soc. C. E., January, 1923, p. 53.

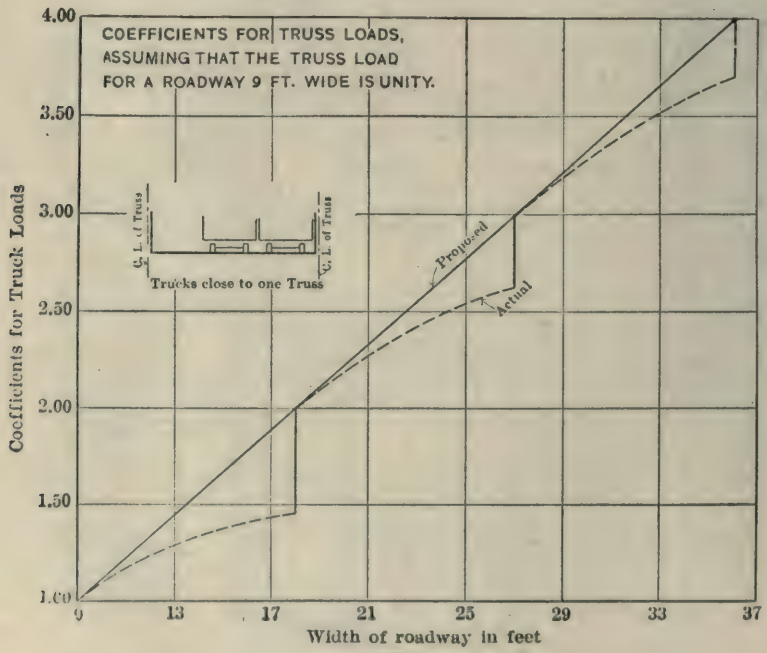


Fig. 4.

of loads to different classes of bridges, the following is proposed:

Class of Bridge	Live Load
Class A, for bridges carrying city and primary highway traffic	T-20
Class B, for bridges carrying secondary highway traffic	T-17.5
Class C, for bridges carrying country traffic	T-15

For a roadway of 18 ft. it would then be necessary for total moments and shears to multiply the moments and shear for a 9-ft. line of traffic by a factor of $\frac{18}{9} = 2$. For a roadway of, say, 24 ft., it would seem to be satisfactory to apply a factor of $\frac{24}{9}$, which is on the safe side, and slightly more than would be found by placing two parallel 9-ft. lines of traffic near one truss and calculating the truss loads from the actual transverse distances. Fig. 4 shows a comparison of the results obtained by this method with the actual truss loads obtained by placing the lines of traffic against one truss. It is seen that the difference between the two curves is not great for roadway widths of more than 20 ft., whereas for a width of 16 ft. it would provide for passing trucks of less than 20 tons each.

Conclusion.—This study of bridge loads has demonstrated that the ordinary uniform loading system is unsatisfactory for modern bridges. A few of the advantages claimed for the proposed new loading system are as follows:

1.—Standardization of highway loads. (Those for railroads standardized in 1895 by the introduction of the Cooper E- Loading.)

2.—Simplicity of specifications.

3.—A definite load for each class of bridge applicable to floor and trusses alike.

4.—A constant longitudinal spacing of loads.

5.—All parts of the load for each class of bridge proportional to a basic typical load.

6.—Moment and shear tables easily prepared and printed for the typical load.

7.—Stresses for any load are found from those for the typical load by simply multiplying by a constant factor.

8.—Encouragement toward uniformity of design and the resulting economy in construction.

9.—Ease of comparison of various designs by establishing a standard basis of comparison.

10.—Uniformity in rating all bridges by establishing a standard basis of rating.

While engaged on this work, the Samuel J. Ott, M. Am. Soc. C. E., Engineer in Charge of Bridge Design, American Bridge Company, to whom acknowledgment is due for suggestions and criticism. Acknowledgment is also due to Mr. Clement Kendall for co-operation in the early stages of the work. Later, this study of live load came under the observation of Otis E. Hovey, M. Am. Soc. C. E., to whom acknowledgment is due for suggestions leading to its continued development.

Trade School Education in Los Angeles

More than 150 apprentice plumbers recently passed examinations and were admitted to the new trade extension school at Los Angeles, conducted by the Board of Education. The examinations consisted of two sets of tests. Ability to master the first test placed the apprentice in the second year work, while those who were able to pass both were graded as third year students.

The course of instruction at the new trades school consists of four hours study a day in both theoretical and practical work. The school does not enroll a student unless he has had previous experience of some kind in the work of his selection. For the actual time spent in the classes of instruction the apprentice-student is paid in full by local contractors who contend that it is good economy to create new recruits to the ranks of their craftsmen rather than outbid other communities for skilled labor.

The tremendous influx of unskilled workers to Los Angeles from all parts of the country where labor unionism is in control made it absolutely imperative that a trades school be established where those who had had some training might become proficient at the trade they had chosen. Being definitely pledged to an open market for material and labor, the Southern California Chapter of the Associated General Contractors has not only heartily indorsed the new trades school but has promised to give it is full moral support and co-operation.

Transmission of Sound by Masonry Partitions

By PAUL E. SABINE
Riverbank Laboratories, Geneva, Ill.

Reprinted from The American Architect and Architectural Review for July 4

In an earlier article, the results of experiments on the transmission of sound by simple stiff structural units of wood, glass, and steel were given. The net result of that investigation was that the sound insulating merits of such units depend more upon the massiveness and stiffness of the structures as a whole than upon the physical properties of the materials employed. Thus a window of $\frac{3}{16}$ in. glass of small leaded panes proved on the whole more effective in reducing sound than a single large pane of glass ¼ in. thick. The experiments also showed that the reduction of intensity varied widely with variation in pitch, but that in general it was greater for high pitched than for low pitched sounds. In a later paper, the effect of materials of what was termed a "quilt-like" character, in reducing sound intensity was considered and the results of tests upon a number of such materials were given.

From those tests, it was possible to give a mathematical expression, involving two experimentally determined coefficients from which the reduction of sound by any thickness could be computed for materials in which the damping forces are great in comparison with the elastic forces. Further, it was shown that interposing layers of impervious material such as heavy building paper increased in a marked degree the effectiveness of porous felt-like materials of this sort is in general in the order of their densities, the more dense materials producing the greater reduction.

The present paper deals with what may be called standard partitions and gives the result of an investigation extending over a period of some two years to determine the relative merits of the various types of masonry partitions commonly employed in modern fireproof buildings. These tests have been made upon an entirely ex parte basis. Manufacturers' associations interested in the various materials tested have very kindly supplied information as to standard practice in the use of their respective materials, and it is a pleasure to acknowledge this co-operation.

The method of measurement was essentially that employed in the previous work and described in the earlier papers. The partition walls of uniform size 8 ft. 2 in. x 6 ft. 2 in. were built in a doorway between a large room 27 ft. x 19 ft. x 20 ft., the Sound Chamber in which the sound was produced, and a smaller room, the Test Chamber 10 ft. 6 in. x 6 ft. 2 in. x 11 ft. 6 in. These two rooms are built upon separate foundations and have no structural connection. Due to the low absorbing power of the Sound Chamber, the sound from the organ pipe sources persists for a considerable time after the pipe has ceased, a matter of some 16 seconds for the lower tones and 6 seconds for the highest tone. By a careful determination of the difference of times which this residual sound can be heard on opposite sides of the test wall, and from the rate of decrease of intensity known from a careful preliminary study of the Sound Chamber, the ratio of the intensities in the two rooms with the test partition intervening can be easily computed. This ratio has been called the Reduction Factor, for the partition, and is a measure of its sound insulating properties. The experiments show that, for a given partition, this Reduction Factor varies widely with the pitch of the sound, so that a complete story can be told only as a result of tests with a large number of tones covering the whole musical scale. In presenting the results graphically, the logarithm of the Reduction Factor rather than the quantity itself will be employed. This mode of representation gives a truer notion of the phenomena as recorded in terms of loudness sensation, since the latter is roughly proportional to the logarithm of the physical intensity of the sound. On the logarithmic scale, zero represents a barely audible sound, 6, a sound of moderate intensity such as that from a violin or a violincello in an empty room of moderate size, and 12, a sound so loud as to be painful. Thus for a complete audible extinction of a moderately loud sound, a logarithmic reduction of 6, which means a reduction in the physical in-

tensity in the ratio of 1,000,000 to 1 is required.

Since the reader of the present paper will be more interested in the final results than in the experimental details, the latter may well be omitted. In the earlier investigations the tests were confined to six or seven tones at octave intervals ranging in pitch from 64 to 4096 vibrations per second. In most of the later work, the number of tones was increased to twenty-three. In most cases the partitions were built a stage at a time and the measurement of the sound reduction produced at each stage was made, each measurement requiring some 1800 separate observations. In this way, knowledge of the relative influence of the separate constituents of the finished partition could be obtained. Careful tests were made to determine the effect of acoustical conditions in the receiving Test Chamber upon the observed intensity. While this effect was not and indeed cannot be wholly eliminated, yet it is quantitatively known and the results given are for constant conditions as between the various types of partitions tested, so that it is believed that they represent the relative merits of these partitions in reducing the passage of sound between adjoining rooms.

Detailed Results for Plaster Walls.—The partitions tested were of three types, namely gypsum block, both solid and hollow, hollow clay tile, and solid plaster on metal lath. The plaster applied to these bases in each case was unfibered gypsum plaster mixed in equal parts with clean sand. This was applied to an equal and uniform thickness on the various bases.

The results for the plaster on metal lath partition will be given somewhat in detail as typical of the whole general procedure. They are instructive as showing the effect of thickness upon the reduction of transmitted sound by what may be considered as practically homogeneous masonry. The specifications for the metal lath base called for ¾ in. channel irons set on 12 in. centers and expanded metal lath weighing 3.1 pounds to the square yard attached by tie wire. The plaster was applied to equal thickness on the two sides, first to a total thickness of 1½ in. Reduction measurements were made on this wall the results of which are shown in the lowest curve of Figure 1. An additional inch of plaster was added, and measurements were again made. The reductions produced by thicknesses up to 4½ in. are shown in Figure 1. One notes that there is a gradual transition in the curves from the form for the thin wall to that for the thickest, indicating that the influence of the metal lath base plays a less and less important part in the transmission of sound as the thickness of the plaster is increased, and that there is generally increased reduction produced by all thicknesses as the pitch of the sound rises. The abrupt increase in the reduction of intensity with rising pitch for the thicker walls in the neighborhood of the tone C_4 is also interesting as indicating a possible difference in the mechanics of transmission of sound above and below this pitch. In practically all the walls tested this same phenomenon

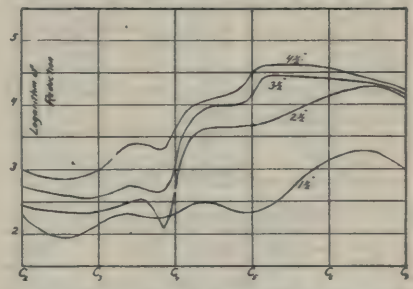


Fig. 1. Reduction of Sound Transmitted by Plaster on Metal Lath Partitions of Different Thicknesses.

was noted. The anomalous case for the tone just below C_4 in which the reduction produced by the 2½ in. wall is actually less than that due to the 1½ in. wall emphasizes the fact already pointed out that comparative tests using a single tone may lead to erroneous conclusions as to the general sound insulating merits of different constructions. Control experiments were performed to determine whether the abnormally small reduction for this particular tone might be due to resonance of the Test Chamber. A small portion of the latter was walled off by means of heavily felted panels, giving a small receiving chamber with high absorbing power. This change was without effect so far as this particular tone was concerned.

The question of the effect of the dimension of the test wall upon the reduction of intensity was also investigated by building a similar wall 2½ in. thick in an opening 3 ft. x 8 ft. The results showed that on the whole

the wall of smaller dimensions reduced the tones below C_4 appreciably more than did the larger wall of equal thickness, but that the results above this tone were not appreciably affected by the area tested. This result is quite in agreement with the theory set forth in earlier papers, that for low tones at least the energy is transmitted mainly by flexural vibrations

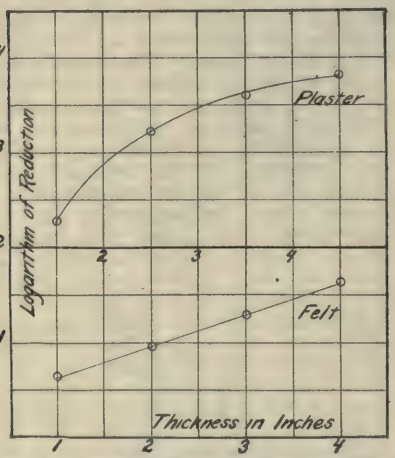


Fig. 2. Average Reduction for the Whole Musical Range Plotted Against the Thickness of the Partition. Upper Curve for Plaster on Metal Lath; Lower Curve for Uncovered Hair Felt.

of the structure as a whole or in large segments.

Attention is further called to the fact that equal increments of thickness do not produce equal increments in the logarithm of the reduction, that is the first added inch of plaster makes decidedly more difference than does the last. This is especially true for the highest tones. This general fact is most clearly shown by the upper curve of Figure 2, in which the average logarithmic reduction for all the tones is plotted against the total thickness of the wall. The straight line in the figure is similarly drawn from the data obtained in earlier experiments with hair felt. The latter indicates that in a porous material like felt the reduction of intensity in transmission is a true absorption process in which each unit of thickness absorbs the same fraction of the energy that enters it as does every other unit, and that any desired degree of sound insulation may be secured by employing a sufficient thickness of the material. The case with the plaster is obviously quite different, and the shape of the curve indicates that there is a limiting value beyond which increasing the thickness produces only a negligible decrease in the transmitted sound. As a matter of practical importance, it may be said that the difference between the 3½ in. and the 4½ in. walls would not be noted by the ear under ordinary conditions, so that it is safe to say that, practically considered, nothing is to be gained in the way of reduced transmission by building partitions of this character more than 3½ in. thick.

Walls With Tile Base.—Hereafter, the graphical presentation of the results will be smooth curves. It should once more be emphasized that the experimental points especially in the two lower octaves do not lie upon smooth curves, the reduction in certain cases varying rather widely from tone to tone due to resonance in the walls themselves. The smooth curves give what may be called average values and present the general trend of change of reduction with changing pitch over the whole range of tones.

In Figure 3 the results of tests on unplastered gypsum tile walls are shown. The tiles were 30 in. x 12 in., and were laid in gypsum mortar. The manufacturers give the composition as 96 per cent calcined gypsum and

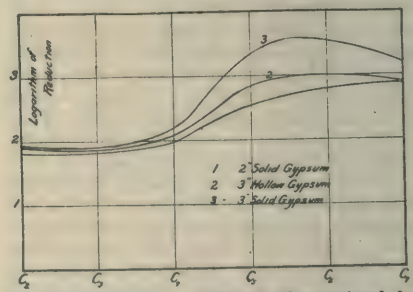


Fig. 3. Reduction of Sound Transmitted by Unplastered Gypsum Tile Partitions.

4 per cent fibre. The weights per square foot including the mortar are given below.

1. 2 in. Solid Tile 10.4 pounds
2. 3 in. Hollow Tile 11.1 pounds
3. 3 in. Solid Tile 14.2 pounds

The very slightly higher values of the Reduction Factor for the 3 in. hollow tile over the 2 in. solid tile of nearly equal weight indicate the negligible effect of the air spaces in the

former. As will appear later in the general consideration of all the results, the factor of weight seems to predominate in determining the reduction of sound in transmission.

The lower curves in Figure 4 show the effect of the addition of plaster to the 2 in. solid tile base. A coat ½ in. thick was applied first on one side. Sound reduction measurements were made, a similar coat was applied to the other side and measurements were

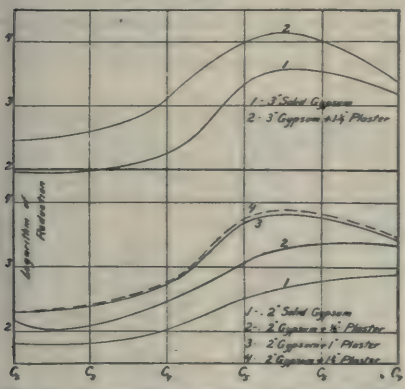


Fig. 4. Curves Showing the Effects of Plastering Gypsum Tile Partitions on the Reduction of Transmitted Sound.

again made. Finally a smooth trowel finish coat of neat gypsum plaster ⅛ in. thick was applied to both sides and measurements made on the finished wall. The very slight change produced by the addition of the finish coat is significant as showing the negligible importance of surface conditions upon the transmission of sound by partition walls. The upper curves of Figure 4, are similarly drawn for the 3 in. tile base and for the finished wall.

In Fig. 5, the reduction produced by a 4-in. hollow clay tile wall in the various stages of construction is presented. These tile, 11½x11¾ in., were set in Portland cement, the unplastered wall weighing 17 lbs. per square foot. The general similarity in the shape of the curve to those preceding is to be noted with the exception that there is a more pronounced falling off in the reduction of tones of the highest octave than occurs with the other types. However, the fact that the shape of the curve for the finished wall conforms closely to those for the other plastered surfaces shows that in the finished structure any peculiarities of the base material are pretty well masked.

Analysis of the Data.—The primary purpose of the present investigation was to secure quantitative data as to the relative importance of the various factors involved in determining the degree of sound reduction produced by masonry partitions. Scientifically we are interested in knowing why wall A reduces transmitted sound more than does wall B, rather than in the bare fact that it does. The passage of energy from room to room through partition walls is a mechanical problem, and one for which no complete theoretical solution has been obtained. The three physical properties involved are mass, stiffness and damping, due to internal friction, of the wall considered as a whole. In the investigation, two of these quantities were measured. The mass per square foot of surface has been chosen as a measure of the first. By subjecting the walls to small pressures and on one side and measuring the displacement of the middle point produced thereby, relative values of the stiffness were obtained. Unfortunately no feasible means of measuring the dampness has yet been devised.

In measuring the relative stiffness, advantage was taken of the fact that the Sound Chamber was sufficiently air-tight so that by admitting air from the organ wind chest into the room the atmospheric pressure could be raised an appreciable amount

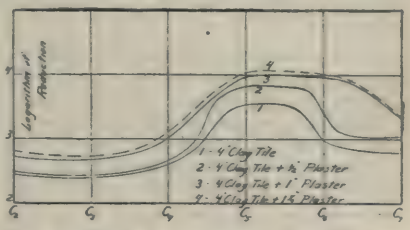


Fig. 5. Reduction of Sound Transmitted by Hollow Clay Tile Partitions.

above the pressure of the Test Chamber on the opposite side of the test wall. This difference of pressure was measured by means of a very sensitive differential pressure gauge. At the same time, the displacement of the middle point of the wall was measured by means of a delicate optical micrometer, that magnified the minute displacements about two thousandfold. The relative stiffness of

the different walls may be expressed by numbers which are proportional to the pressures necessary to produce a given deflection.

In order to have a single numerical value as a measure of the reduction of sound intensity, the value of the logarithm of the reduction factor averaged for all the tones has been chosen. This procedure is justified by the fact, that with few exceptions, there is a general similarity in the shapes of the curves given above,

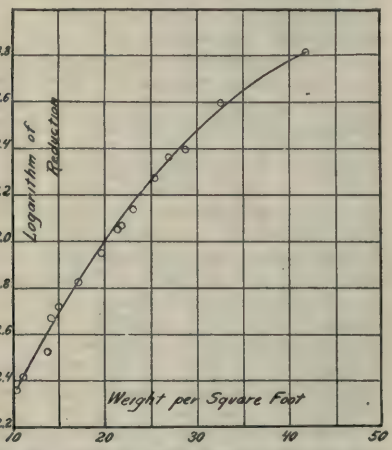


Fig. 6. Average Reduction of Sound Over the Whole Musical Range Produced by Masonry Partitions Plotted Against the Weight Per Square Foot of Surface.

and therefore the average affords a fair measure of the relative merits of the various walls as sound insulators.

In the following table, the results of all the tests are summarized. The figures in the column headed "Relative Stiffness" are computed from the displacements described above, and are the hydrostatic pressures in hundredths of a pound per square inch necessary to produce a yielding of .01 in. at the middle point of the wall.

Inspection of this table shows immediately which of the two factors, mass or stiffness, is determinative in the reduction of intensity of transmitted sound by walls of this general character. Sound reduction and mass per square foot run in the same order. On the other hand, there is no obvious correspondence between stiffness and sound reduction. Thus, for example, No. 11, the stiffest wall, does not give the greatest reduction, No. 8 and No. 14, about equally stiff, differ widely in the average reduction factors.

In Fig. 6, the figures for mass and reduction factor are plotted. The departure of the experimental points from the smooth curve are no greater than can be acccunted for by the unavoidable uncertainty in estimating the weight of the walls. Obviously the conclusion to be drawn is that within the limits of variation of physical properties set by the scope of the present investigation, mass is the deciding factor in the matter of sound transmission, and that any advantage of one wall as compared with another is a matter simply of its greater weight, rather than of any intrinsic merit in the material employed in its construction. It appears then that the sound insulation between adjacent rooms separated by masonry partitions, is determined by the weight per square foot of such partitions. Moreover from the data of the table and the curve of Fig. 6, it is possible to state the reduction of general sound intensity produced by any wall of this general character solely from consideration of its weight.

From a purely practical point of view, it appears that the advantage in sound insulation of any one of the types of construction tested, over

No.	Wall	Average Logarithm of Reduction	Wt. per sq. ft.	Relative Stiffness	Average Reduction
1	2 in. Gypsum Tile, unplastered	2.36	10.4	.....	230
2	3 in. Hollow Tile, unplastered	2.42	11.1	.....	260
3	1½ in. Plaster on Metal Lath	2.53	13.9	4	340
4	3 in. Solid Gypsum Tile, unplastered	2.67	14.2	.....	468
5	2 in. Solid Gypsum and 1½ in. Plaster	2.72	15.	.....	525
6	4 in. Hollow Clay Tile, unplastered	2.83	17.	.....	677
7	2 in. Gypsum and 1 in. Plaster	2.95	19.6	.....	892
8	2 in. Gypsum and 1¼ in. Plaster	3.05	21.4	84	1120
9	4 in. Clay Tile and ½ in. Plaster	3.07	22.	.....	1180
10	2½ in. Plaster on Metal Lath	3.24	23.2	17	1740
11	3 in. Solid Gypsum and 1¼ in. Plaster	3.28	25.4	130	1910
12	4 in. Hollow Clay Tile and 1 in. Plaster	3.36	27.	.....	2300
13	4 in. Hollow Clay Tile and 1¼ in. Plaster	3.40	28.8	120	2500
14	3½ in. Plaster on Metal Lath	3.60	32.5	77	4000
15	4½ in. Plaster on Metal Lath	3.82	41.8	.....	6600

the others does not make a very strong "talking point" in favor of its use. For walls of equal thickness the solid plaster gives the greater sound reduction, because of its greater weight. For the same reason solid tile of a given thickness is more effective than hollow tile of the same thickness. As between the finished walls on the tile bases and the 2½-in plaster wall, on the metal lath base the difference in sound reduction is not great enough to furnish a very strong argument in favor of the use of any one of them as compared with the others.

The investigation serves to indicate the limitations of ordinary partition walls in reducing the transmission of sound. Roughly speaking, a logarithmic reduction of 3 may be expected for walls as ordinarily built. This reduces sounds of moderate loudness from 1,000,000 times to 1,000 times minimum audibility. The latter are faint but distinctly audible. For the complete extinction of ordinary sounds a further reduction of 3 on the logarithmic scale (1,000 to 1 in physical intensities) would be required. Obviously from the curve of Fig. 6, this would require walls of prohibitively great weight and thickness. Even a total logarithmic reduction of 4 would require a wall weighing more than 50 lbs. per square foot, a figure for partitions which probably could not for structural reasons be tolerated save in exceptional cases. The investigation is now being extended to distinctly different types of construction with the hope of finding a more practicable method of reducing the passage of sound from room to room.

Wages of Contractors' Workmen in London, England, Area

(From the Surveyor, London.)

The Public Works Conciliation Board for the London area—namely, the City and County of London and the whole of the districts of all the local authorities, the whole or any part of whose district lies within the Metropolitan Police district—has decided that the present rate of wages (X in the schedule) for the City and County of London remain at 1s. 4d., (32 ct) and that the rate for the area beyond the City and County of London and to the limits of the Metropolitan Police area be not more than one penny less than the X rate in the City and County of London—to be effective for the three months, October, November and December, 1922.

In the following schedule the laborers' rate equals "X"; for the City and County of London the laborers' rate is 1s. 4d. (32 ct.)

Trade.	(d = 2 ct.) Plus rate.
Blacksmith	X plus 4½d
Concrete leveler	X plus —
Duct or earthenware drain layer	X plus 1d
Fitter	X plus 4½d
Granite mason (curb, etc.)	X plus 5½d
Granite sett dresser	X plus 4½d
Jointer	X plus 1d
Curb fixer	X plus 4½d
Paver	X plus 4½d
Petrol locomotive or roller driver	X plus 2d
Platelayer	X plus 1d to 2d
Platelayer laborer	X plus —
Pneumatic pick operator	X plus 1d
Rammerman	X plus 1d
Scaffolder	X plus 3d
Screeder	X plus 1d
Steam roller driver	X plus 4d
Street mason and flag dresser	X plus 4½d
Tarpot man	X plus —
Timberman	X plus 1d
Wood block layer	X plus 1d
Watchman	X plus 7s 6d*

*Minimum day or night.

Men working in "boots" 1d per hour extra.

Workmen working in dirty or dangerous places subject to special rates and conditions.

Boys 14 to 16 years	⅓ of X
Boys 16 to 18 years	½ of X
Boys 18 to 20 years	⅔ of X

The hours of labor and overtime rates to remain as agreed on March 11, 1920, namely:

"The recognized working week shall consist of forty-seven hours, and when overtime is worked at the request of the employer, or his agent, the following rates shall apply: For the first two hours in any one day, time and a quarter; for the second two hours, time and a half; after that, double time; Saturdays noon to 4 p. m., time and a half, and after that double time; Sundays and Bank Holidays, double time. The working day to commence at 7 a. m., and end 5 p. m. One and a half hours to be allowed for meals. Saturdays commence 7 a. m., and end noon. Half an hour to be allowed for breakfast."

This award supercedes all others of earlier date.

Opportunities and Purposes of the American Institute of Architects as Stated in a Section of the Report of the Board of Directors Rendered May 16, 1923

Herein lies perhaps the greatest opportunity for service to the industry that is open to the architect, and it appears to be a service that no other branch of the Industry is so naturally equipped to render. And it is by such activities that the Institute of today stands in quite sharp contrast to the Institute of a decade ago. Then our activities relatively speaking were largely self-centered. Our educational work was almost entirely concerned with the professional training of architects; our membership was exclusive rather than inclusive, intended as a mark of a certain degree of distinction rather than a general token of honorable and competent practice; there were 35 Chapters; our discussions of competitions dealt largely with provisions for the control of our own actions; we maintained a dignified aloofness from labor, which was regarded as a problem of the contractor with which it were best for the architect to have no connection; we were concerned with standardizing contract procedure for the benefit of architects and their clients and contractors; we were active in support of public measures for the protection of the Capital City, but too often opposed by a lack of understanding of our qualifications and purpose.

Today there are significant changes to be recorded. Our educational work, while not neglecting the professional practitioner, is actively dealing with the great problem of primary art education of the public; our membership basis has broadened and has for its goal the inclusion of every honorable and competent architect, having 52 Chapters and a membership more than doubled; our consideration of competitions is developing standards not merely for ourselves, but for the use and enlightenment of our legislators in order that wise procedure may be laid down in the public's interest; we have extended the hand of friendship and cooperation not only to labor, but to all of the other elements so intimately related to our own, as vital factors in our industry, with interests that are more clearly seen to be in common rather than in conflict; we are reaching out to inform the public of our ideals, our purposes and functions, rather than contenting ourselves with mutual confessions of the public's ignorance; the almost insolvable problem of the small house builder has been accepted as a task worthy of the profession, not only as a unit, but in its group significance as a community planning problem, and we begin to build up a practical denial of the slur that was once just, that in spite of our noble professions our art was available only to the classes that could afford it, and not to the great masses that needed it even more; the perplexing modern structural problems are having a due share of our attention and we are forming for the first time direct contact with the great body of material producers; our study of contract provisions has spread to include all those other branches of the Building Industry in which the architect plays but a minor part, but yet in which his own work is now furnishing the chief contribution; and at last our desire to be of assistance to our Government in the solution of its building problems sees new reasons for hope in the awakening respect for the opinion of the profession and the growing appreciation of its capacity for public service.

"In all this broadening of the activities and influence of the Institute and the profession there is cause for no little satisfaction, tempered, however, by the sober realization of the steadily increasing labors that lie ahead, in the performance of which the Institute will need in varying degree the personal service of its members, but in a uniform and generous degree their thoughtful, sympathetic and loyal support."

Servicised Products Incorporates.—On Aug. 15 the Servicised Products Corporation, A. C. Fisher, President, took over Mr. Fischer's Chicago office at 38 S. Dearborn St. and the plant at Desplaines, Ill., which was formerly operated by Mr. Fischer as the Servicised Products Company (not incorporated). The new organization is incorporated under the laws of Illinois, and is expected greatly to facilitate the Servicised Products business in expansion joints, roofing materials, fibers, waterproofings, etc.

Co-operation Between Engineer and Architect

Abstract in the Southern Architect and Building News of an Address Before the Municipal Engineers' Society of New York City

By ROBERT D. KOHN
Vice-President American Institute of Architects

There has always been a misunderstanding between architects and engineers as to their particular functions. In recent times this has become more noticeable because there have been distinct instances where the engineers felt that the achitects have intruded on their field, and there were frequent occasions when the architect felt that the engineer had invaded the field of architecture. What we need more than anything else as between the two professions is a clear understanding of the respective functions of the two professions. The field is large enough to need no rivalry. The subject itself is one that would lead us far afield and take much time to cover. Let us suffice for the moment to point out that what is needed is co-operation and not competition. The two professions supplement each other.

What Architecture Is.—Architecture is not the art of applying decoration or ornament, or "piling up" ornament on a structural form. It is the art of seeing into every elemental form and into the complete structures certain fundamental conditions that make for better-looking structures. The beauty that we all desire in everything that surrounds us has to be of the essence of the structure or form, not merely applied to it. By proper co-operation between the engineer and architects these results can be attained. And incidentally, the study of good form and beauty is not the sole function of the architect. But until now he has alone studied adequately the amenities of life in many directions; in other words, those gracious features which make a structure something other than merely a shelter against the intemperance of the climate or weather.

Perhaps the whole thing can be summed up by such a case as the Pittsburgh bridge which was the subject of endless debate a year or two ago among the Pittsburgh engineering societies because the design of a great highway bridge was given to a firm of architects. The protest was in part justified. The design should have been jointly into the hands of engineer and architect. The element of good appearance should at the very outset be kept in mind in the design of a bridge as well as any other public structure, street development or parkway. It is unnecessary to point out to an audience of this kind how successful such co-operations of engineer and architect have been.

Co-operation in War Time Building.—A splendid illustration of what co-operation can do is furnished by some of the war-time building in the various services of the government. The particular service in which the speaker was engaged (the housing division of the Shipping Board) was particularly fortunate to have had the co-operation of all the professional men joined in it. The engineering division in charge of Morris Knowles of Pittsburgh, the construction division under W. G. Luce of New York, and the design division under F. L. Ackerman of New York, very soon realized what could be accomplished by a joint study of every problem at the very beginning of every procedure. In other words, during that strenuous period of war-time activity, the architect, the engineer, the construction man, the division man in charge of materials and transportation, the men in charge of layouts for water supply, gas and electricity and street layouts, all sat down together and discussed everything from available material to the nature of the soil and possible schemes of sewerage disposal. The full import of every housing project was thus at least touched upon at the very outset, and each division responsible for the solution of any part of the problem was conscious of the elements of the problem faced by the others. By the middle of 1918 the whole procedure had been immensely improved by reason of this co-operation. Shortly after the armistice, at a conference held in Philadelphia attended by probably a hundred of the leading engineers, architects and construction men associated

with the Shipping Board housing division, there was only one sentiment expressed as to the most marked influence of joint work in that government service. It was that each one realized the inestimable value of co-operation in the whole construction field.

The Congress of the Building Industry.—There has been one exceedingly interesting outcome of this wartime work. In a measure it was responsible for the creation of what has been called the Congress of the Building Industry. This congress movement started about two years ago, and now has local branches in New York, San Francisco, Portland, Boston and Philadelphia, in which the membership consists of seven or eight groups of men connected with or interested in the building industry. Generally, the groups are engineers, architects, contractors, sub-contractors, labor, real estate and finance.

The congress was formed to bring together all of those elements for joint discussion of their problems. It was agreed at the start that all contentious subjects like wage rates and conditions of labor, on which there is always a disagreement between employer and employee, should be eliminated from the discussions of the congress. It was recognized that these topics would always be a source of disagreement, but it was felt that there are innumerable problems with which the building industry is faced which can only be solved by joint study of all those interested. That the principle on which the building congress is based is correct is evidenced by the results already attained in the establishing of an apprenticeship school for carpenters, sheetmetal workers, painters and others, and the studies of seasonal unemployment and other subjects of importance to the building industry. What has been most effective is the fact that the best results here and elsewhere are always attained when all the elements concerned in any particular problem work them out together, rather than one group imposing its will on the rest.

Results of Co-operation.—In conclusion, it seems important to point out that what can be accomplished by the engineer can be accomplished by the engineer and architect co-operating in their own field can in a still greater measure be advanced by reason of the professional men getting to advance the causes of value to the public. The professional man is impotent in public affairs—as a rule he is in the minority. It is rare in any public service of the government to find a man of technical ability at the head of any department. Some layman is generally put in charge, and he goes through the motions of directing the work, whereas the men who really know how to do it are generally in the position where they have to take orders and fight ignorance and in some cases worse. With the exception of Mr. Herbert Hoover, who, perhaps as the result of his wartime service, is now in the government service, it is hard to find another technical man who has ever held a position of importance in the Federal government service.

Almost every subject in the way of public improvement interests all of the professions. The subject of housing, which has been endlessly discussed in the last few years, is not, for instance, a subject for the architect alone nor for the engineer alone. It interests those two professions, but it also interests the physician in the matter of public health; it interests the social worker from the point of view of the family in certain fields, the law, items of land ownership, the proposition of maintenance and community ownership and utilities, etc.

When all the professions are brought together in some joint body to act on public questions that arise —when the weakness of a single profession acting on any public matter is overcome by the weight that can be put behind any movement by joint action, then the professionally-trained men of the country will receive from the government the consideration that they should have. Then and then alone will we begin to get into the government an adequate measure of that competence and technique which private corporations are wise enough to buy, but which our municipal, state and National governments have never seemed to be willing to pay for or get by any other means. It is to that larger vision of the possibility of co-operation that the speaker appeals for your individual support and for the support of organization like the municipal engineers.

The Architect and Illuminating Practice

Extracts From Paper Presented June 6 Before San Francisco Architectural Club

By W. L. STOCKWELL
Illuminating Engineer, San Francisco Division, Pacific Gas & Electric Co.

The illminating authorities of today feel that in general the architects are lagging behind in illuminating practice, and as a rule, that they are not providing for sufficient lighting facilities when making up their plans and specifications. No great blame attaches to them for this as it is recognized that illumianting practice has advanced so fast as to make it rather difficult to keep fully abreast of the art when one has so many other matters demanding attention.

Advantages of Increasing Light Intensity.—Wiring plans and illuminating layouts that were good practice and entirely satisfactory yesterday, are apt to prove poor practice and very unsatisfactory today, as witness the following instances:

Recent tests conducted by the Postoffice Department have shown that by raising the intensity of light used in one of their offices from 3.6 foot-candles to 8 foot-candles there was a gain in labor output to the amount of three dollars for each dollar that was expended in the improvement of the lighting installation.

After 16 months of careful testing, the Detroit Piston Ring Company of Detroit, Mich., found that by increasing their light intensity from 1.2 foot-candles to 14 foot-candles their production was increased 25 per cent at a cost to them of an amount approximating but 2 per cent of their payroll.

As a result of these and many other tests and surveys that have been made, engineers estimate that there is lost through poor lighting in the industries, labor output to the value of 20 ct. per day per man, a total for the United States as a whole, of two and one-half billion dollars annually.

In the merchandising field also, higher intensities of light are being coined into dollars. Great material benefits are therefore derived from the use of higher light intensities, evoluting practice ever tending to accentuate possibilities to the full.

When it is realized that daylight intensities measure hundreds and thousands of foot-candles while an average of but 10 foot-candles of artificial light is not yet standard practice, some idea may be gained of what the future holds in probabilities.

The Factor of Quality.—In addition to intensity in lighting, there must also be considered the factor of quality. To maintain a fixed intensity of light and enhance its quality demands as a rule, an additional expenditure of electric energy, and these two factors, i. e., higher intensity and better quality of light necessitates access to greater electrical energy at the wiring outlet.

Great educational forces are at work bringing these factors to the attention of the general public and it is highly desirable that the architect should lead rather than follow this trend.

It might interest you to know that right here in California there has been installed by one mercantile firm, lighting intensities in its show windows comparable to broad daylight. Some two thousand foot-candles in fact, or putting it another way, their installation calls for approximately 200 watts of electrical energy demand per sq. ft. of area of the window floor.

Among other advantages derived from this installation may be mentioned the overcoming of specular reflection in the plate glass front making it possible for the observer to gaze at the window display without suffering annoyance from reflected images of the street, opposite buildings, etc. To anyone who is familiar with the objectionable nature of specular reflection in display windows this result alone would seem to justify the expense of installation and maintenance.

Formula for Lighting Installation.—For the purpose of engineering a lighting installation, a very simple formula has been found adequate, to-wit: The square feet of floor area multiplied by the desired foot-candle intensity, divided by the coefficient of utilization, the result being expressed in lumens, or units of light flux emitted by the light source. All standard lamps are now rated in lumen output.

This application of the formula determines the size of the lamp necessary to produce a given foot-candle intensity. Per contra, by multiplying the lumen output of a lamp by the coefficient of utilization and dividing by the area in square feet, you arrive

at the foot-candle intensity that will be available.

How the Architect Functions Efficiently as an Illuminating Engineer.—Permit me then to visualize the architect functioning efficiently as an illuminating engineer. He first turns to his table of recommended intensities, then knowing the dimensions of the room and the color of the walls and ceiling and having at least an approximate idea as to the type of luminaire to be used, he turns again to his table and secures the coefficient of utilization, applies the simple formula aforementioned and accurately ascertains the necessary wattage.

When it is appreciated that one watt per sq. ft., for instance, will produce either, ½ foot-candle or 7 foot-candles, depending upon the conditions involved, the necessity for an accurate method of estimation is apparent.

Concrete Building Block and Concrete Building Tile

Proposed Standard Specifications Submitted by Committee P-1, on Standard Building Units at 1923 Convention of American Concrete Institute

1. The purpose of these specifications is to define the requirements for concrete block to be used in construction.

2. The word "concrete" shall be understood to mean portland cement concrete.

Strength Requirements.

3. The average compressive strength of concrete block 28 days after being manufactured or when shipped shall not be less than 1,500 lb. per sq. in. of gross cross-sectional area as laid in the wall, and the compressive strength of any individual block shall not be less than 1,000 lb. per sq. in. of gross cross-sectional area as laid in the wall.

4. The gross cross-sectional area of a block shall be considered as the product of the length times the width of the unit as laid in the wall.

Absorption Requirements.

5. Concrete block shall not absorb more than 12 per cent of the dry weight of the block when tested as hereinafter specified except when they are made of concrete weighing less than 140 lb. per cu. ft. For block made of concrete weighing less than 40 lb. per cu. ft., the average absorption in per cent by weight shall not be more than 10 multiplied by 140 and divided by the unit weight in lb. per cu. ft. of the concrete under consideration.

Sampling.

6. Specimens for tests shall be representative of the commercial product of the plant.

7. Five specimens shall be required for each test.

8. The specimens used in the absorption test may be used for the strength test provided they have been dried at approximately seventy (70) degrees Fahrenheit for not less than three days.

Methods of Testing

Strength Test.

9. The specimens to be tested shall be carefully measured for overall dimensions of length, width and thickness.

10. Bearing surfaces shall be made plane by capping with plaster of paris or a mixture of portland cement and plaster which shall be allowed to thoroughly harden before the test;

11. Specimens shall be accurately centered in the testing machine;

12. The load shall be applied through a spherical bearing block placed on top of the specimen;

13. Metal plates of sufficient thickness to prevent appreciable bending shall be placed between the spherical bearing block and the specimen;

14. The specimen shall be loaded to failure;

15. The compressive strength in lb. per sq. in. of gross cross-sectional area is the total applied load in lb. divided by the gross cross-sectional area in sq. in.

Absorption Test.

16. The specimens shall be dried to constant weight at a temperature of from two hundred and twelve (212) to two hundred and fifty (250) degrees Fahrenheit and the weight recorded. After drying, the specimens shall be immersed in clean water at approximately seventy (70) degrees Fahrenheit for a period of twenty-four (24) hours. They shall then be removed, the surface water wiped off and the specimens re-weighed. The absorption is the weight of the water absorbed, divided by the weight of the dry specimen and multiplied by one hundred (100).

The Workability of Concrete Mixtures

Results of Simple Penetration Test Described in Paper Presented June 28 at 26th Annual Meeting of American Society for Testing Materials

By J. C. PEARSON and F. A. HITCHCOCK,
Physicist and Associate Engineer Physicist, U. S. Bureau of Standards

It is not easy to define the terms "workability," "plasticity," "consistency," etc., as applied to concrete mixtures. Some authorities use these terms more or less synonymously, others prefer to distinguish between workability and consistency, considering the latter as a property directly related to water content and measurable by the slump, flow, and other tests, whereas workability is regarded as more intrinsically a characteristic of a given mixture, dependent not only on the water content, but essentially upon the other ingredients of the mixture. We incline to this latter view, and without attempting to give an exact definition of workability, we consider one concrete mixture more workable than another when the processes of mixing, handling and placing are accomplished with less effort in the one case than in the other. The direct quantitative measurement of this effort, for example, in placing a concrete mixture in any sort of a form or mold is a very difficult thing, chiefly because there is no telling when one arrives at a definite condition that may be taken as a stopping point in the placing operation. We have made attempts to measure the workability of various concrete mixtures in this way, but thus far without success.

A Direct Segregation Test.—During the past two or three years we have given a great deal of thought to the possibilities of measuring the workability of concrete by some indirect method. If one has had considerable experience in handling concrete mixtures in the laboratory, one gets the impression that those mixtures are the most workable which tend to preserve their homogeneity in greatest degree as they are being handled and placed in forms. Thus a relation is suggested between the workability of a mixture and its tendency to segregate, and we felt that the development of a satisfactory method of measuring segregation would help to solve the problem. After trying and discarding numerous schemes we developed a direct segregation test which was briefly as follows:

A concrete mixture was brought by trial to a given consistency (flow) and then placed in a 6 by 12-in. cylindrical mold made of two 6 by 6-in. sections, the lower section having a water-tight bottom. The mold was fastened upon the flow table, and the latter was raised and dropped for a definite number of times, causing the concrete to settle in the mold. The amounts of

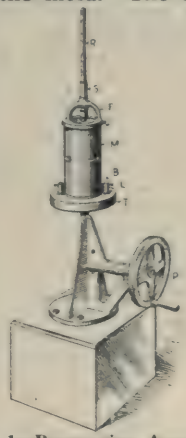


Fig. 1—Penetration Apparatus.

coarse aggregate in the upper and lower sections of the mold were then determined by washing the fine material through a No. 3 sieve, and weighing the residues. Comparing different concretes in this manner, we found that large differences in segregation were clearly indicated, but the uncertainty of the determination was such that small differences were obscured. After doing a great deal of work in the endeavor to improve the accuracy of this test, we discarded it with a feeling that some simpler solution must be found.

In the course of the segregation experiments the impression grew upon us that the most noticeable characteristic of the harsher working mixtures was a greater tendency to settle and pack in the container—this was noticeable even in the mixing pan and on the

flow table, as well as in the segregation mold. While this tendency to pack seemed to be due to segregation, the test described above indicated that segregation was not the only factor involved. Thus we were led to devise some comparative measure of the packing, and following the usual procedure of starting with complex schemes and proceeding to the simple, we eventually came to the penetration test which is the subject of this paper.

Apparatus Used in Penetration Test.—The apparatus used in the penetration test is shown in Fig. 1. M is a 6 by 12-in. pipe mold with a watertight bottom, fitted with slotted lugs, L, by means of which the mold is fastened to the small drop table T. The latter is in reality an ordinary flow table with a special top carrying two clamp nuts, B, which engage the lugs, L, of the pipe mold. The table top can be raised and dropped through a height of ⅛ in. by means of a cam on the end of the shaft P. Fitting the top of the pipe mold closely is a detachable brass spider F carrying a fixed sleeve S, which, when the frame is in position on top of the mold, is exactly in alignment with the axis of the mold. The sleeve S is ¾ in. inside diameter and 6 in. long. A steel rod, R, ¾ in. diameter, 20 in. long, weighing 1100 g. completes the apparatus. The lower end of the rod R is hemispherical, and the upper portion is graduated in 0.1 in. in such manner as to read directly the depth of the lower end below the top of the mold when inserted in the sleeve S.

Method of Test.—The mold M with the brass spider F clamped to the top is fastened to the table by means of the clamp nuts. The batch of concrete to be tested is scooped into M until the latter is filled to the brim. No attempt is made to puddle the concrete into the mold, but a rod is used

Table I—Materials Used in Penetration Test.

Material	Weight per Cubic Foot, lb.	Specific Gravity	Gradation
Aggregates			
Potomac River Gravel	101.2	2.65	¼ to ½ in., 50 per cent ½ to ¾ in., 50 per cent
Potomac River Sand	109.1	2.65	
Mixed Aggregate	120.5	2.65	

Sample	Retained on Sieve, per cent						Fineness Modulus	Surface Modulus
	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100		
No. 1	2.5	15.8	26.7	40.4	70.3	90.4	2.46	30.0
No. 2	1.9	15.2	26.8	41.0	71.1	90.9	2.49	29.5
No. 3	2.2	15.5	26.8	40.8	71.0	91.0	2.47	29.5
No. 4	2.2	15.5	26.9	41.0	71.2	91.1	2.48	29.3
No. 5	2.1	15.7	28.1	42.5	72.2	91.3	2.52	28.7
Aver.	2.2	15.6	27.1	41.2	71.2	91.0	2.48	29.4

Admixtures

			Percentage finer than		
			0.01 mm.[a]	0.02 mm.[a]	No. 200 Sieve
Cement	89.4[b]	3.15	21.0	31.9	82.7
Hydrated Lime	31.8[b]	2.25	79.8	95.1	98.8
Kaolin	34.5[b]	2.55	63.8	90.0	99.6
Celite	10.4[b]	2.00	100[c]	....	....

[a] Determined by air elutriation

[b] Determined by the method specified for fine aggregates of the Standard Method of Test for Unit Weight of Aggregate for Concrete (C 29 – 21), 1921 Book of A.S.T.M. Standards.

[c] Determined by water sedimentation.

to spread the concrete uniformly as it falls from the scoop. After the mold is filled, the table top is raised and dropped a given number of times to subject the concrete to a definite amount of compacting force. Our practice throughout has been to give the concrete thirty ⅛-in. drops. At the completion of the preliminary jolting or settling, the rod R is inserted in the sleeve S and lowered gently into the concrete until it comes to rest under its own weight. The table is then raised and dropped, and from the force of the impact the rod penetrates a certain distance into the concrete, indicated by the reading of the scale. The impacts are repeated and the successive penetrations of the rod are noted until the latter has reached nearly to the bottom of the mold. In practically all of our tests the penetration has been carried to a depth of 11 in.

In order to obtain comparable results in the penetration tests, we felt it necessary to use the same grading of coarse aggregate in all mixtures. This aggregate was selected from the results of preliminary experiments, and composed of Potomac River gravel, 50 per cent ¼ to ½ in., and 50 per cent ½ to ¾ in. We should have preferred to use coarser material as more typical of commonly used aggregates, but it is obvious that the penetration of the rod into the concrete involves the displacement of aggregates in an annular space of 2⅝ in., if anything too small, rather than too large, for the free movement of the aggregate. We did not wish to increase the size of the mold, and consequently the size of the batches, unless it seemed necessary to do so; on the other hand, the aggregate as selected was entirely suitable for certain types of reinforced concrete in which the working qualities are perhaps of greatest importance. It was especially important also that the sand be as uniform as possible throughout the tests wherein the effects of other variables were being studied. In order to insure the uniformity of the sand without going to the very great labor of screening and recombining in definite proportions, the entire lot (about five tons) was mixed on the floor of the laboratory in a damp condition, sacked in that condition and allowed to dry in the sacks. When the mixing was completed, five widely separated samples were taken for sieve analysis. The results of the sieve tests are given in Table I. The very close agreement in the sieve analyses shows that the method is quite satisfactory. In weighing out the batches, the sand was scooped from the sacks, thus minimizing any tendency toward segregation in the individual sacks.

Significance of the Test.—Even if one has never seen or used the penetration test it is quite obvious that different mixtures should show different resistances to the penetration of the

Table II—Summary of Test Data From Series II.

Number	Mix. by Weight	Admixture,[1] per cent by weight of Cement	Mix. by Volume	Admixture, per cent by volume of Cement	Admixture by absolute volume, per cent	Number of Tests	Water to Dry Materials, per cent[2]	Water-Cement Ratio	Flow[3]	Slump[3]	Compressive Strength at 28 days, lb per sq in[4]	Workability Figure
1	1:3:6	0	1:2.5:5.3	0	0	16	9.9	1.42	111	7.2	1914	183
2		1.7 C		14.4	2.6	5	10.2	1.46	109	7.5	1155	162
3		3.3 C		28.7	5.3	5	10.7	1.53	107	7.4	1139	144
4		5.0 C		43.1	7.9	8	11.1	1.59	110	7.7	1082	94
5		5.0 K		13.0	6.2	8	[illegible]	1.43	111	7.4	1068	143
6		10.0 K		25.9	12.4	8	[illegible]	1.48	113	8.0	1080	112
7		15.0 K		38.9	18.5	6	10.8	1.55	110	7.7	1022	123
8		5.0 L		14.1	7.0	8	9.8	1.40	110	6.9	1222	160
9		10.0 L		28.1	14.0	8	10.1	1.45	108	7.5	1202	140
10		15.0 L		42.2	21.0	6	10.5	1.50	116	7.4	1156	140
11	1:2½:5	0	1:2.0:4.4	0	0	13	9.7	1.18	[illegible]	7.5	[illegible]	138
12		1.7 C		14.4	2.6	5	10.4	1.27	111	7.8	1681	125
13		3.3 C		28.7	5.3	5	11.1	1.35	108	7.8	1539	91
14		5.0 K		13.0	6.2	7	10.1	1.23	109	7.3	1474	101
15		10.0 K		25.9	12.4	7	10.5	1.28	110	7.9	1242	86
16		5.0 L		14.1	7.0	7	[illegible]	1.22	110	7.6	1454	141
17		10.0 L		28.1	14.0	7	10.2	1.24	109	7.1	1410	129
18	1:2:4	0	1:1.6:3.5	0	[illegible]	14	9.9	0.99	111	7.8	2307	92
19		1.7 C		14.4	2.6	5	10.5	1.06	112	8.2	2168	57
20		3.3 C		28.7	5.3	5	11.6	1.16	110	8.4	2125	48
21		5.0 K		13.0	6.2	6	10.4	1.04	110	8.0	2018	56
22		10.0 K		25.9	12.4	6	11.0	1.10	110	7.8	1844	44
23		5.0 L		14.1	7.0	6	10.1	1.01	109	7.6	2046	97
24		10.0 L		28.1	14.0	6	10.6	1.06	109	7.7	1974	62
25	1:1½:3	0	1:1.2:2.6	0	0	6	10.2	0.90	109	8.4	2622	57
1	1:3:6	10.0 C	1:2.5:5.3	96.1	15.8	9	12.6	1.81	108	7.7	936	53
2		15.0 C		129.2	23.7	5	14.5	2.08	111	7.9	778	30
3	1:2½:5	5.0 C	1:2.0:4.4	43.1	7.9	7	11.5	1.40	111	7.9	1372	55
4		10.0 C		86.1	15.5	7	13.4	1.63	109	7.8	1116	43
5	1:2:4	5.0 C	1:1.6:3.5	43.1	7.9	6	12.0	1.20	107	8.0	1866	32
6		10.0 C		86.1	15.8	6	14.2	1.42	109	8.2	1578	22

[1] C = Celite, K = Kaolin, L = Hydrated Lime.
[2] Exclusive of Admixture.
[3] Flow figures, the average from all tests. Slump figure, from a single determination
[4] Strength, the average from 5 tests except for 1:3:6, 1:2½:5 and 1:2:4 plain concrete, in which case the average is from 10 tests.

rod, the more plastic mixtures allowing the rod to penetrate readily, the harsher mixes offering high resistance. As stated in the introduction, the property that we were admittedly trying to measure was the tendency of a mixture to pack under a definite amount of settling or compacting. This we seemed to have accomplished, judging from the results of a considerable number of preliminary experiments, but a more complete interpretation was lacking. It was primarily to furnish an interpretation of this test that the present investigation was undertaken; incidentally the investigation was so planned as to contribute some interesting information regarding the effects of certain powdered admixtures.

Results Obtained From the Penetration Test.—The first series of experiments selected to check the indications of the penetration test was performed on a range of concrete mixtures with and without additions of high-calcium hydrated lime, Delaware kaolin, and "celite," a variety of diatomaceous earth furnished by the Celite Co., of Los Angeles, California. This series involved 25 different concrete mixtures, each tested on a number of different days, and all gaged as nearly as possible to the same consistency as measured by the flow table. The consistency selected for these experiments was such as would be suitable for good reinforced concrete, and gave a flow of 110, corresponding to a cone slump of 7 to 8 in.

The 25 concrete mixtures used in Series I are listed in Table II, together with a summary of the test data. In explanation, it may be stated that the series was first planned and carried out with an arbitrary selection of admixtures, in amount 5, 10, and 15 per cent, respectively, (by weight of

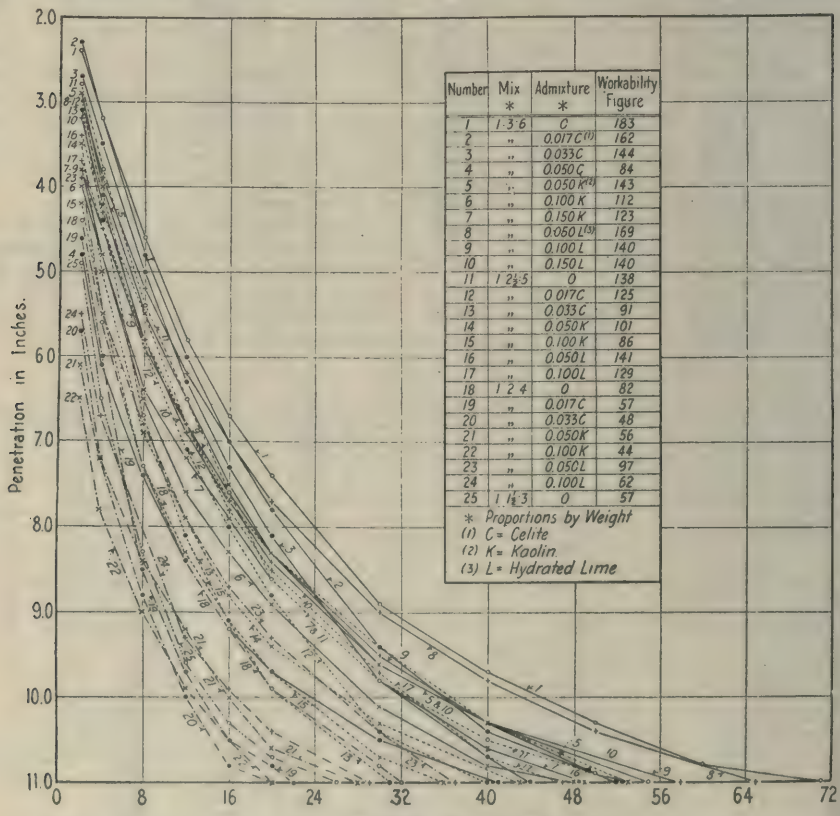


Fig. 2—Penetration Impact Curves for 25 Concrete Mixtures Gaged to the Same Consistency (Flow).

cement) for the 1:3:6 mixtures, and 5 and 10 per cent for the 1:2½:5 and the 1:2:4 mixtures. The unexpectedly large effects produced by the celite rendered it advisable to reduce the quantity of this admixture to one-third of these amounts in order that the effects might be more nearly comparable with those produced by the kaolin and the hydrated lime. The results obtained with the larger additions of celite are listed at the bottom of Table II.

After considerable thought, the proportions of the ingredients of the concretes were selected on a weight basis, partly for convenience, chiefly to insure the use of definite quantities of the admixtures. There is no standard method of determining the weights of unit volumes of fine powders, and such determinations are subject to great variations depending on the method used. However, certain values were obtained by using the method prescribed for measuring fine aggregates, and on the basis of these values, the proportions by volume were determined and are included in Table II. As there are certain arguments for comparing the effects of different admixtures on the basis of absolute volumes, the proportion of cement to admixture on this basis for each concrete mixture is also given in Table II.

The penetration tests on the 25 mixtures given in Table II yielded the set of curves shown in Fig. 2, which is included mainly for the purpose of illustrating the method of plotting penetration against the number of impacts, and showing the range of results obtained on concrete mixtures gaged to the same consistency. The interesting feature is that with very few exceptions, these curves occur in the order of the workability of the concretes to which they correspond, so far as we were able to judge by the behavior of the mixtures during the operations of mixing, handling and placing in the molds. Thus the nearer a curve is to the left-hand side of the diagram, the more workable the concrete from which it is obtained, or, in other words, the fewer the number of impacts required to cause the rod to penetrate to a given depth, the more workable the mixture. This general relation immediately suggests that the number of impacts required for the rod to reach a given depth, say 11 in., in a given concrete mixture might be taken as a workability figure for that mixture. The objection to this is that the curves do not all show the regularity of a mathematical family, and it is, therefore, advisable to find some workability figure which depends, not on any one point of a curve, but upon the curve as a whole. We have tried a number of methods of doing this, but none seems more satisfactory than the computation of the area under each curve as shown in the diagram, that is, the area enclosed by the curve, the axis of penetration and the 11-in. penetration line. The order of these areas agrees very satisfactorily with our estimate of the order in which the curves occur, and these are the figures given in the last column of Table II. It is not to be inferred that these empirical figures are directly proportional to the actual workability of the concrete mixtures, but they do serve to indicate the order of workability and to permit comparisons to be made of different mixtures in this respect.

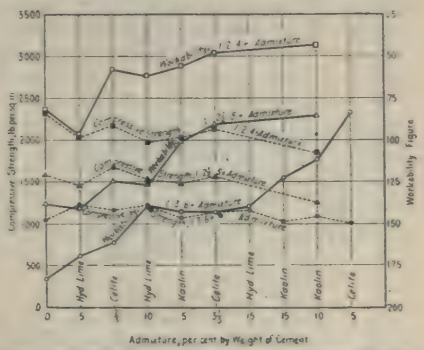


Fig. 3—Effect of Different Quantities of Celite, Kaolin and Hydrated Lime on Strength and Workability of Concrete Mixtures. Workability Figures Connected by Full Lines; Strength Values Connected by Dotted Lines.

In Fig. 3 the workability figures and the strength values from Table II are plotted opposite the various concrete mixtures arranged approximately in order of increasing workability. It is to be noted that the workability figures decrease as the workability increases, hence, these figures increase from the top to the bottom of the diagram in order that the workability curves may have the usual significance, that is, the curves rise as the workability increases. It is seen that the compressive strengths tend to drop with increasing proportions of the admixtures, and that as a rule increased workability involves a sacri-

fice in strength. In the case of the 1:3:6 mixtures, however, practically no loss in strength resulted from any of the admixtures, but on the other hand a gain in strength was usually obtained; up to nearly 20 per cent for the 5 per cent and 10 per cent admixtures of hydrated lime. It will be observed here and subsequently that the workability figures for the lime admixtures are noticeably more erratic than the others, due, we believe, to the fact that the lime admixtures produced very rapid changes in consistency during the first four or five minutes after the concrete was mixed, within which period both the flow and penetration tests were made. The highest workability for the 1:3:6 mixtures was obtained with 5 per cent of celite, which gave a value about equal

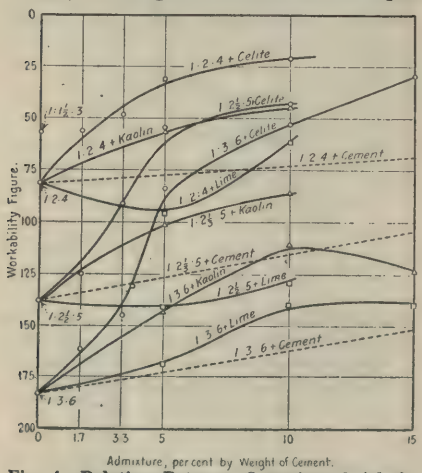


Fig. 4—Relation Between Quantity of Admixture and Workability of Concrete Mixtures.

to that of the 1:2:4 mixture, with practically no loss in strength. In general, the strengths of the richer mixtures drop to some extent when admixtures are used, but it should be remembered that the cylinders are cured under damp conditions, whereas under job conditions the effects of the admixtures might, and probably would, be very much more favorable. This is a very important consideration, and should be adequately covered in any subsequent investigation of the effects of admixtures upon the strength of concrete. This is also an increased yield in the concretes containing the admixtures, and this fact should not be overlooked in the final balancing of accounts.

In Fig. 4 the workability figures for the mixtures of Table II are plotted against percentages of admixture (by weight of cement). Curves are thus obtained which show clearly the relative effects of the various admixtures. Incidentally, the curves show where apparently inconsistent results have been obtained; for example, there is no explanation of the fact that 15 per cent of kaolin gave a lower workability than 10 per cent of kaolin in a 1:3:6 concrete mixture, nor that an addition of 5 per cent of hydrated lime lowered the workability of a 1:2:4 mixture. On the other hand, the curves indicate with certainty thatt he effect of celite upon workability is greatest for all mixtures, and that the effect of kaolin is intermediate between that of celite and hydrated lime. It is possible also to get roughly approximate comparisons of the amounts of the various admixtures which give the same workability. For example, 10 per cent of hydrated lime in the various mixtures has about the same effect, on the average, as 5 per cent of kaolin, 2.5 to 3 per cent of celite and about 20 per cent of cement. The workability figures are not determined with sufficient accuracy, however, to justify putting too much weight on direct quantitative comparisons of this sort.

It appears from the foregoing tests that the effect of any admixture on the workability of concrete is dependent mainly upon fineness, not necessarily upon the fineness of the powder in the dry state, but the fineness of the material as measured by the completeness of its distribution in the mixture. Thus, the celite, which is exceedingly fine in the dry state, appears to be very thoroughly dispersed in the concrete mixture, required a considerable increase in the amount of mixing water. Both the kaolin and the lime, if thoroughly soaked in water before being added to the concrete, would undoubtedly have a greater effect upon workability than they do under the conditions of these tests, but in the few minutes which are available for wetting them when added as dry powders, they do not have opportunity to break up and thus produce the degree of plasticity obtained with the celite. The increased plasticity of the matrix which the admixtures bring about seems to have a double effect in that it tends to preserve the homogeneity of the concrete mixture as a whole, and at the same time to have a distinct lubricating effect. Any tendency to lessen segregation must fa-

cilitate the movement of the penetration rod as it goes deeper into the concrete mixture, but where previous experience, as stated in the introduction to this paper, has shown that the segregation is not appreciably lessened, the easier penetration of the rod must be accounted for by easier displacement of the aggregates.

Relation Between Workability and Consistency.—In the tests of Series I every effort was made to maintain the flow of the various concrete mixtures at a figure of 110. In Series II an equal amount of effort was devoted to using such quantities of mixing water as would produce flows of 80, 95, 125 and 140 in a number of typical mixtures. For this purpose 15 of the mixtures used in Series I were employed, namely, the 1:1½:3, 1:2:4 and 1:3:6 mixtures without admixtures, and the 1:2:4 and 1:3:6 mixtures each with two percentages of celite, lime and kaolin, respectively. Flow and penetration tests were made on each mixture and on each consistency on five different days. The results of these tests, together with the results obtained from the same mixtures in Series I, are shown graphically in Fig. 5. In this diagram the workability figures obtained from the penetration tests are plotted against flows.

The irregularities of the curves in Fig. 5 indicate very clearly that the penetration test is not a precision test, but in spite of this fact some very interesting general relations are evident. In the first place it is apparent that the effect of change in consistency on the penetration is much less marked than the effect of changes in the character and proportions of the solid ingredients. Thus the 1:2:4 and the 1:3:6 mixtures each show a range in workability of about 40 points from the driest to the wettest mixtures, whereas the 1:2:4 curve is roughly 80 points above the 1:3:6 curve. We are led to the conclusion, therefore, that the workability of a concrete mixture, as indicated by the penetration test, is dependent not so much upon the water as upon the solid materials in the mixture. If this is actually the case, it calls for a somewhat different conception of workability than that indicated in the introduction to this paper. It must be admitted upon first consideration that the workability as indicated by the results of these tests is not in line with our former notions of workability, but recalling our intimate contact with the 400 or 500 batches upon which the curves in Fig. 5 are based, we believe there is a point of view from which we may see a direct and valuable relation between the results of the penetration tests and workability. If we use the term "workability" to mean, not merely the degree of effort required in handling and placing concrete, but the degree of effort required in handling and placing concrete in such manner as to give a uniform and homogeneous finished product, then we may declare that the results of the penetration tests confirm our judgment on the workability of concrete mixtures.

It seems to us that this is quite an important conception and one which emphasizes the proper course to pursue in selecting the type of concrete mixture for any particular purpose. Within the limits of accepted practice

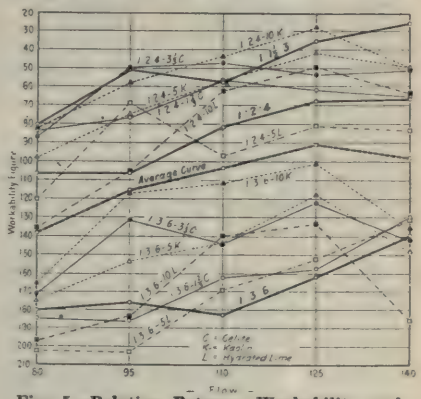


Fig. 5—Relation Between Workability and Flow of 15 Concrete Mixtures.

the consistency of reinforced concrete will generally correspond to a flow somewhere between 110 and 140. Without taking into account the increase in strength obtained by the use of less water, the penetration test indicates, as shown by the "average" curve in Fig. 5, that there is not a great difference in workability between these consistencies if we take into account the work required to get an equally good distribution of concrete in the finished job. In other words, if one wants a good job of concreting, he can get it with a flow of 110 about as easily as with any wetter mixture. The over-wet mix may be chuted with a minimum of labor, but excessive segregation gives poor distribution unless additional labor is supplied to take care of this. On the other hand, if too dry a mixture is

used, the lack of lubrication lowers the workability, and additional work must be done to insure elimination of pockets and voids.

Perhaps the most interesting indication from these tests, aside from that which has just been discussed, is that a maximum workability is indicated at a flow of 125. This maximum would be somewhat more pronounced on the "average" curve were it not for the inexplicable rise of the three lowest curves between flows of 125 and 140. This again emphasizes that dependable quantitative values of workability cannot always be obtained from a small number of penetration tests as made with the present apparatus. In passing, it may be noted that the curves for the lime admixtures tend to be more erratic than the others and that the position of the curves confirms the relative effectiveness of the various admixtures as obtained from the tests of Series I. It is interesting to note also that the effects of the admixtures on the 1:2:4 concrete are on the whole as marked as on the 1:3:6 concretes.

The Workability of 1:2:4 Concrete as Affected By a Variety of Admixtures and Changes in Fine Aggregate.—Having carried the investigation to a point where a reasonable interpretation of the penetration test could be made, we decided to check its indications on a number of additional mixtures. These were compounded on a 1:2:4 basis with a number of new admixtures, and included two modifications of the fine aggregate. The consistency or flow was held throughout at very nearly 110, as in the first series. Test cylinders were also made from these mixtures for the determination of compressive strength at 28 days. In all cases, penetration tests and cylinders were made for each mixture on five different days, the results being obtained from the average of five tests.

The cement used was a different brand from that used in Series I and II, but both fine and coarse aggregates were the same as before, except as noted below for mixtures Nos. 2 and 3. The admixtures were selected from materials close at hand, some of them probably representing nearly the attainable limit in respect to fineness. For brevity, the following list of mixtures names only the admixture in most cases, it being understood that 5 per cent of the admixture by weight of cement was added to the basic 1:2:4 mixture, No. 1, unless otherwise stated.

No. 1.—Normal 1:2:4 mixture, the same in all respects as the corresponding mixture in Series I, except in brand of cement.

No. 2.—Same as No. 1, except that the fine aggregate was prepared by removing the portion (29 per cent) of the normal fine aggregate passing the No. 50 sieve.

No. 3.—Same as No. 1, except that the fine aggregate was prepared by removing the portion (27 per cent) of the normal fine aggregate retained on the No. 16 sieve.

The approximate sieve analyses of the fine aggregates in these first three mixtures was as follows:

Sieve	Percentage Passing No. 1	Percentage Passing No. 2	Respective Sieve No. 3
No. 4	98	97	100
No. 8	84	78	100
No. 16	73	62	100
No. 30	59	42	81
No. 50	29	0	40
No. 100	9	0	12

4. Basic Magnesium Carbonate.—A very light powder, comparable with celite in appearance and weight per unit volume. This material produced an unexpectedly quick set in the concrete, the mixture being quite hard within 30 minutes after mixing.

5. Short Fiber Asbestos.

6. Asbestine.—Finely pulverized asbestos, used as an extending pigment for paints.

7. Carbon Black.—Used commercially as a rubber filler, and purchased on an order specifying "best grade gas black."

8. Zinc Oxide.—Used commercially as a rubber filler. This material interfered seriously with the set of the concrete, which was barely hard enough to remove from the molds 24 hours after mixing.

9. Flake Graphite.

10. Caustic Magnesia.—Low-burned magnesite which hydrates rapidly when fresh. The sample used had been stored for some months and was not noticeably active.

11. Pulverized Talc.

12. Pulverized Blast-Furnace Slag.

13. Calcium Chloride.—A 4 per cent solution of commercial chloride was used as gaging liquid.

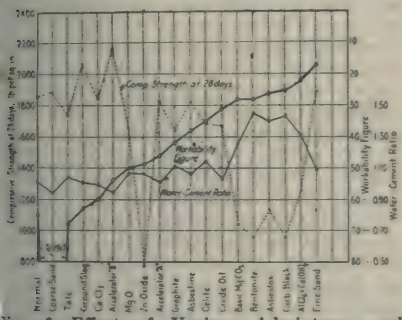
14. Accelerator "A."—A proprietary material containing calcium chloride and hydrated lime in the form of calcium oxychloride.

15. Accelerator "B."—A proprietary material in liquid form said to

ontain calcium chloride and organic urpassed all others in workability as ndicated by the penetration test. The xplanation of this unexpected result s the fact that the fine sand matrix lmost completely prevented segrega- ompounds and known to have a lower urface tension than a plain calcium hloride solution.

16. Aluminum Chloride and Hy- rated Lime.—An aluminum chloride olution was prepared containing an mount of anhydrous salt equal to 2.5 er cent of the weight of the cement. An equivalent amount of hydrated ime was stirred into this solution pro- lucing a gelatinous precipitate of luminum hydroxide. This was poured nto the concrete mixture and enough dditional water was added to give the esired consistency.

17. Bentonite.—A highly colloidal lay, added to the mixture as a thin



ig. 6—Effect of Various Admixtures and Changes in Fine Aggregate on Strength and Workability of 1:2:4 Concrete Mixtures.

lip containing 1.25 per cent of the dry naterial by weight of cement.

18. Celite.—Similar to the ma- erial used in Series I and II, but from n old lot which had been stored in the aboratory for a year or more.

19. Crude Oil.—A heavy residuum il, incorporated in the wet concrete nixture by vigorous mixing.

Results of Tests.—The results of he penetration and compression tests f this series are shown graphically in ig. 6. The mixtures are plotted ap- roximately in the order of their orkability as indicated by the heavy ne curve. It is seen that the strength nds to decrease with increasing orkability and that the water- ement-radio curve tends to reflect the rength curve. There are numerous regularities, however, and in some cases these are of considerable significance.

The results of the variations in fine aggregate are particularly interesting. The normal 1:2:4 mixture gave a workability considerably higher, and a strength about 20 per cent lower, than the corresponding mixture in Series I. This indicates a considerable difference in the characteristics of the cements used in the two series of tests. The coarse sand mixture, requiring a water ratio of 0.94 for the medium consistency, was very harsh and gave a lower workability than the normal 1:3:6 mixture in Series I. The fine sand mixture requiring a water ratio of 1.09 gave the highest workability obtained, but the strength of this mixture, and also of the coarse sand mixture, was practically identical with that of the normal mixture.

The authors consider the results of the tests on these three sand mixtures as almost convincing evidence of the fallacy of specifying gradation limits for a fine aggregate without regard to the concrete mixture in which it is to be used. The fine sand, which is unquestionably the best for the concrete used in these tests, would be rejected as unsuitable for fine aggregate on most existing specifications.

What is more important in connection with this investigation, however, is the fact that the fine sand mixture tion, this apparently having greater effect on workability than the higher lubrication afforded by such admixtures as bentonite and aluminum hydroxide.

Space is not available for a description of the behavior of all the admixtures, and a brief reference to the outstanding results obtained will conclude the paper. Basic magnesium carbonate and zinc oxide gave low strengths, each of these interfering with the normal setting and hardening of the concrete. Short fiber asbestos and carbon black gave very high workability, but low strength due to excessive quantity of mixing water required. Pulverized blast-furnace slag did not greatly improve workability but increased the strength about 11 per cent. Bentonite and aluminum hydroxide seemed to give the highest degree of lubrication, and consequently high workability, but serious reduction in strength resulted from the excess of mixing water required. Crude oil gave good lubrication, but the great objection to this material is the diffi-

culty of incorporating it thoroughly in the mixture. Its tendency to rise to the surface of the concrete is also a serious objection to its practical use. The celite used in this series was somewhat less effective in increasing the workability than that used in the first series of tests; nevertheless, in this series also it leads the admixtures that might be consireded from a commercial standpoint. Under the conditions of these tests it reduces the strength about 10 per cent. The results from the accelerators are interesting in confirming to some slight extent our theories of workability and strength. Accelerator "A" is a calcium oxychloride which quickly decomposes to calcium chloride and hydrated lime when mixed with water. The hydrated lime thus freed is much more effective upon workability, as indicated by the results of these tests than the dry hydrated lime alone, which seems to confirm our belief that in the duration of the mixing process the dry material is not effectually dispersed. Accelerator "B" gave the highest strength obtained and an appreciable improvement in workability. Whether or not the reduced surface tension of this compound is responsible for these effects we cannot say, but the fact that a smaller amount of mixing water was required for the desired consistency seems to point to this conclusion.

Summary and Conclusions. — The penetration test described in this paper is the first worthwhile solution of the problem of measuring the workability of concrete which the authors have found in a research extending over a period of several years. As used in this investigation, the test is lacking in desirable precision; it furnishes a measurement of workability in arbitrary units only, and it is not applicable to the entire range of concrete mixtures. On the other hand, these faults can probably be eliminated, and even in its present stage of development, its indications seem correct and in accord with the best judgment of a number of experienced operators. This is true if workability is defined as that property of a concrete mixture upon which depends the amount of work required to handle and place the concrete uniformly, under the ordinary conditions of use.

As indicated by the penetration test, the workability of a concrete mixture seems to depend upon two factors, segregation and lubrication. It appears that both of these factors can be controlled by a suitable selection of ingredients, an increasingly fine aggregate reducing the segregation, and powdered admixtures reducing segregation and promoting lubrication. This increase in workability brought about by the use of finely divided admixtures seems to be proportional to the fineness as measured by the completeness or extent of dispersion of the material in the mixture. Thus, celite was found to have greater effect in improving the workability of concrete mixtures than kaolin, and kaolin a greater effect than hydrated lime.

In studying the relation between workability and consistency, as indicated by the penetration and flow tests, respectively, the interesting conclusion was reached that workability depends more on the character and proportions of the solid ingredients in the concrete than on the amount of mixing water used. Although this conclusion may appear open to question, the authors believe it to be correct, and they also believe that false notions in regard to workability of concrete have been created by reference to chuting operations. The facility with which concrete flows down a chute is probably dependent both upon workability and water, the effect of the latter predominating in the overwet mixes. Whatever the facts may be, the indications of the penetration test substantiate the authors' opinion that there is no premium upon, and rarely an excuse for, employing a consistency higher than that giving the maximum workability obtained in these tests.

Under damp storage conditions, small quantities of admixtures generally increase the strength of lean mixtures, even though they require an increase in the amount of mixing water for a given consistency. The richer mixtures under the same conditions suffer a slight loss in strength. It is important, however, that further work be done to establish the effects of admixtures under drying conditions, where it is quite probable that strength, as well as workability, will be benefited. It is important also that further work on the subject include studies of the relative yield and shrinkage of concretes with and without admixtures, since these factors must be taken into account in determining the resultant effect in the finished product.

Safety Code for Contractors

The following safety code for the rotection of workmen on construc-on operations has been prepared by e General Contractors Association Cleveland:

General.—Superintendents and fore-en should feel their responsibility the endeavor to prevent accidents, nd it is their duty to see that tools, quipment and materials used are in ood condition.

Use judgment in assigning men to o certain work, and be sure they are apable.

Call attention of men to any danger-us conditions on the job so that they an be on the lookout.

Post conspicuous signs warning the ublic to keep out.

Post danger signs where necessary.

Station watchmen where necessary.

See that the instructions of the ain office as to the proper way of aking out accident reports are car-ied out.

Instruct your men to report all acci-ents no matter how trivial. Minor njuries neglected produce most of the nfection cases.

The change or increase of any par-icular hazard, or a new undertaking hat increases the possibilities of acci-ent, should be reported by telephone o the main office.

In case of accident or injury to quipment requiring inspection or re-airs, before resuming operations call he main office.

If observation shows evidence of nything more than the most casual azard to pedestrians or the public, ncluding employes of other con-ractors, or the owner, notify the head ffice immediately, so that insurance overage may be sufficient.

Follow the code—do not take long hances. Men have no right to do so, or others may have to take the conse-uences. Careless workmen cause ac-dents, so insist on your men being areful.

Eyesight Protection.—See that each mploye whose work requires it is rovided with and wears a pair of oggles which are suited to the work be performed and which fit him operly.

Do not give goggles from one work-an to another without their being erilized. Goggles are classified as llows:

(a) To protect eyes from flying objects and molten metal.

(b) To protect eyes from injurious light and heat rays.

(c) To protect eyes from gases, fumes or liquids.

(d) To protect eyes from dust and wind.

See that you have them on the job.

Respirators should be provided for men working with cement, lime and other dusty material; also in smoky and gaseous places.

Sanitation.—Typhoid fever, dysentery and other diseases are often caused by lack of proper sanitation on the job.

It is essential that adequate and suitable toilet conveniences be provided at the start of operations.

If sewerage is available, connections should be made at once and running water provided to keep closet flushed.

Flush tank closets should be installed where practicable.

A privy is not recommended, but if used, it should be disinfected daily by the use of chloride of lime or other suitable disinfectant.

See that all buildings used as temporary toilets are kept in a clean and sanitary condition.

Drinking Water.—Fresh and pure drinking water must be provided. Make connections with city water line, if possible. Drinking bubblers of approved type should be installed when possible.

See that pail and dipper used by water boys are kept clean.

On outlying jobs, if drinking water is obtained from wells or other local sources, its purity should be assured. Have it tested if there is any question.

Lumber Lasts Well

The oldest landmark in Orange, Texas, a frame building located on the old Henry Thompson place, opposite the Holland Hotel on Division St., was recently torn down.

More than 50 years ago the Thompson's store building, a two-story structure said to be the most commodious of its day, was constructed of Orange manufactured lumber, within a few feet of the Sabine River on what is now Division and Water streets.

In demolishing the old-time structure, the carpenters found that the lumber was in a splendid state of preservation.

Length of Working Week Cut 36 Minutes in 2 Years; Now Average Is 50.3 Hours

That the length of the working week of the average American employee declined 36 minutes during the last two years is indicated by the report Employment, Hours, and Earnings, in Prosperity and Depression which gives in detail the results of a survey made by the National Bureau of Economic Research for President Harding's Conference.

According to some historians, our great-grandfathers thought 12 hours a reasonable day's work. For more than a hundred years, however, the length of the working day has been declining steadily until, as the report "Employment, Hours, and Earnings, in Prosperity and Depression" shows, the average American in the first quarter of 1922 was expected by his employer to work only 50.3 hours per week, just a trifle more than the eight hours for six days set forth as an ideal by reformers of a generation or two ago. The detailed figures covering all industries in the United States show that the lengths of the working week declined 36 minutes during the two years covered by the study. The recent reduction of hours in the steel industry will lower still further the average of 50.3 hours.

Of all classes of employers reporting, those engaged in rendering domestic and personal service record the longest full-time hours for those working under their direction, the average being slightly more than eight hours daily for a seven-day week. Farmers and retail merchants each require over 53 hours of work per week from their employees.

Builders Below Average.—Employers in a considerable group of industries usually call for less than 48 hours per week from their workers. This group includes building and construction, finance, public and professional service, paper and printing establishments, and factories making textiles, clothing, leather, and leather goods.

The figures presented in the report indicate that the man who is anxious to have a steady job in dull times as well as in good times should seek a position with a small employer. However, if he followed this course during the last few years, he may have discovered that he gained less than he expected by the choice, for the tables show that in the last quarter for which reports are available he was asked to work 53 hours each week in the small enterprise instead of 47.8 that the large establishment on the average required him to serve. This difference is partly accounted for by the fact that farmers form so large a portion of small employers. However, the farmers are not the only ones of this class that call for longer hours than the average.

Shorter Work Day in Big Houses.—In 9 out of 17 industries, employers hiring fewer than 21 workers required their employees to work over fifty hours per week in the first quarter of 1922.

In the group employing 21 to 100 workers, long hours for employees proved to be even more common than in the smaller enterprises at the same date, for 12 out of the 17 industrial groups had full time hours of more than 50 per week. Only in concerns employing over 100 men were shorter hours the rule. In that group, only 7 of the 17 industries expected their men to work as much as 50 hours per week.

Chicago Zoning Commission.—It is gratifying to note that Mayor Dever, of Chicago, has appointed Allen B. Pond, F. A. I. A., to be chairman of the Zoning Board of Appeals. It is right and proper that an architect should be chairman of such an important Board. Mr. Pond has, with his brother and partner, Irving K. Pond, always been active in movements for the betterment of Chicago and has served on important committees of the City Club. It is particularly important that this Board be well selected as it will have a tremendous amount of work to do in connection with the zoning ordinance recently adopted in that city. Another appointment to this Board is Charles Bostrom, Building Commissioner. Mr. Bostrom has filled that important post for the past eight years with entire satisfaction, and was chairman of the Zoning Commission and very influential in securing the adoption of the new ordinance. With these two, a real estate expert, an attorney and an engineer will constitute the Board.

[Editorial in The American Architect and The Architectural Review.]

Maple, Beech and Birch Flooring

Comparative Merits and Other Features Discussed in an Article Contributed to "Architecture and Building" by the Indiana Flooring Co.

While the architect or builder must of necessity almost daily figure on hardwood floors, it is safe to say that of no item of building material is there such a misconception of grades, sizes and general qualifications as there is of maple, beech and birch flooring.

The architect or builder will figure on a certain building. He knows that maple floors are desirable. Therefore he specifies maple. He probably says, "Best grade of maple flooring, 13/16 x2¼ in. and lets it go at that, forgetting, if he has ever known, that the chances are at least even that some other grade but the "best" grade, some other size but 13/16x2¼ and, in many cases, beech or birch flooring will suit the requirements much better than the stock he has really specified, and that he can not only save money but can render his client a distinct service by a better knowledge of these floors.

The "three sisters" of the strip flooring world as maple, beech and birch flooring have come to be known, are produced in the same mills in Michigan. Where maple is found, there, as a rule, will be beech and birch also, and a better understanding of what these three woods are, where they are best adapted for use and their points of resemblance or dissimilarity would be extremely valuable to everyone connected with construction work.

There is many a maple floor in this country that has stood daily wear and use for half a century. In the old days these floors were worked by hand, but between 1880 and 1890 a new craze struck this country—roller skating rinks. This craze was responsible more than any one thing for the impetus given the manufacture of this flooring. It was soon found that no wood but maple would stand the constant wear and tear of the rollers. While other woods quickly succumbed, maple stood the test and, instead of wearing out or becoming rough and uneven, the constant use in the roller rinks only made the maple floor better. The flintlike resistance to wear and the glassy surface made an instant appeal and the demand grew so great that in a very short time the maple flooring industry had grown to undreamed-of proportions. Machinery had taken the place of the jackplane and the floor as we now know it came into being.

A glance at the comparative wearing qualities of wood flooring, as given below, show instantly why maple, beech or birch flooring have won the place they have. Tests made show that the comparative wearing qualities of these woods as compared with oak are:

First, maple.
Second, beech and birch.
Third, quarter sawn oak.
Fourth, plain sawn oak.

Oak, the floor for the home, will be taken up in a later article, but this story deals only with maple, beech and birch, the floors of utility and service. Maple, particularly, is the floor for hard usage, but is very often used and is very satisfactory for kitchens and other rooms in a home where the decorative quality is not so much a consideration. Waxed or varnished maple assumes a yellow or golden color. Beech can be used for almost any work where maple might be specified. Birch has a richer color than either of maple or beech, and takes a finer stain or finish.

Where maple is supreme, however, is in its wearing quality, as shown above. For factories, warehouses, schools, department stores, dance halls, in fact, for any building where long life and ability to withstand heavy traffic is the great consideration, there maple comes into its own and leads the field in floors. The statement that maple will outwear stone is literally true.

The manufacture of maple, beech and birch flooring has become a highly specialized industry in recent years. Those in the industry have realized that the conservation of the Nation's timber resources was a very vital matter, and the result has been that the manufacturers have united in an effort to utilize, by standardizing sizes, grades and lengths, every foot of lumber possible. The result has been that four standard widths of these floorings have been adopted, these widths being 1½ in., 2 in., 2¼ in. and 3¼ in. These widths cover the flooring tongued and grooved only

as, in addition, square-edged or jointed flooring, 3½ in. wide, is manufactured, but all the product, tongued and grooved or jointed, is endmatched. The width most commonly used is 2¼ in. face, but there is hardly a place where 2¼ in. can be used where 1½ in. or 2 in. is not just as desirable, and where these widths cannot be substituted, and the lesser cost of the flooring, as a rule, will make up for the extra laying cost. In fact, many who have used the narrower stock prefer it to 2¼ in., as the narrower the piece the more uniform it will run for color and the fewer blemishes or defects will be found.

The 3¼ in. face and jointed stock are used largely in factory or industrial buildings where there is a large area to be covered and where the cost of laying is a feature. The wider stock naturally goes down faster and the saving in this regard is considerable.

Besides the 13/16 in. flooring, two other thicknesses of maple flooring are in ordinary use. 1 1/16 in. stock made from 1¼ in. lumber is used often in buildings where there is an extraordinary strain or where heavy trucking is done. This stock naturally has much greater wearing quality than the 13/16 in. flooring and its use has been largely increased in the last few years. Flooring ⅜ in. thick is also manufactured, this, as a rule, being laid over old floors. Where a new hardwood floor is desired over an old softwood or other hardwood floor, the ⅜ in. has proven highly satisfactory. The ⅜ in. floor can also be procured in beech and birch, but in the 1 1/16 in. thickness only maple is used as, where this thick flooring is required, wearing quality is the first consideration.

How to figure the amount of flooring required to cover a given area is a question that often bothers the builder or architect. Inasmuch as ¾ in. is allowed over the actual width to take care of the matching of this flooring and, in measuring say 13/16x 2¼ in. flooring the size really used is 1 in.x3 in., the following table, which shows the percentage it is necessary to add to the floor space to ascertain the number of feet, board measure, required to cover, may be of value:

Matched Stock 13/16 in. thick
1½ in. face, 50% or ½ additional.
2 in. face, 37½% or ⅜ additional.
2¼ in. face, 33 1-3% or 1-3 additional.
3¼ in. face, 23 1-13% or 3-13 additional.

For 1 1/16 in. flooring, 25% additional must be added to the above. The ⅜ in. flooring, as a rule, is made only in 1½ in. face, for which 33 1-3% must be added, and 2 in. face, for which an additional 25% is required.

It is a cause of common complaint that the grade names of maple, beech and birch flooring are misnomers. There are three standard grades, "CLEAR," "NUMBER ONE" and "FACTORY," and while these names have by long usage become familiar to users, there is still considerable misunderstanding of what the grades stand for.

The "Clear" is the highest grade manufactured and in ordinary use, although occasionally a special grade selected for color is made, further mention of which is made below. The rules governing the grading of maple, beech and birch flooring say that the clear grade shall be practically free from all defects, but the question of color shall not be considered. Thus, in practical terms, the grade must have a fact that will not materially mar the appearance of the finished floor or impair its durability. Small pin knots (if not too many), burls or black or green streaks are not prohibited, short tongue is to some extent admitted, but the face must be free of checks and shake and the wood must be live and sound.

The "Number One" grade is just as serviceable as is the clear and is equally as desirable where there is no objection to the appearance, and can be used in the same class of buildings as the clear as a material saving in cost. The best description that can be given of this grade is found in the official rules of the Maple Flooring Manufacturers' Association, and is as follows:

"This grade is made for service rather than appearance. It admits of tight, sound knots, prominent discolorations, numerous dark green or black spots or streaks, slight checks not exceeding three inches in length and running parallel with and well inside of the edges of the strip, dark spots or streaks with slight checks in center, small rough spots which

cannot be wholly removed by the ordinary method of smoothing the floor when it is laid, slightly torn edges, short tongue is sufficient to hold properly in the floor, shallow or waney back if piece has sufficient bearings of full thickness to support it in floor, and slight variation in angle of end matching. While these and similar features are admissible, sufficient attention is given to appearance to make this grade desirable and satisfactory for use in stores, school houses and similar places where a waxed or varnished floor is not required.

The rules say that "Factory" grade "must be of such character as will lay and give a good serviceable floor with some cutting." This grade is suitable for factories, warehouses and like uses, and, where a low priced floor is wanted for wear alone, nothing better can be obtained.

In addition to the standard grades, it is also possible to secure a clear grade of maple flooring, all white, or a clear grade of either beech or birch, all red. The manufacturers sort this stock for special work. The clear white grade of maple flooring is almost ivory white, while the clear red beech and clear red birch are free from all defects, as is the maple, and these three grades are the finest that it is possible to produce.

While maple, beech and birch flooring will now show as long lengths as some woods, it must be remembered that the fact that the shorter lengths are utilized means so much more lumber conserved to the Nation and that the day when these valuable woods will be exhausted is so much further away. The short lengths are really as valuable as the longer ones, as the stock is all end matched, and, short or long, the pieces go together into one solid floor. From the standpoint of conservation and economy, therefore, the specifying of special lengths in these products is a mistake.

In economy and in ability to withstand wear, maple, beech and birch flooring, the "three sisters," stand in a class alone. No matter what the type of building, wood flooring has a place in it, and each day is bringing a clearer understanding of the wonderful possibilities of these woods from the northern forests.

Right of Architect to Damages for Unauthorized Use by Owner of Building Plans and Specifications

By LESLIE CHILDS

From Architecture and Building for July

The question of the right of an architect to damages, for the unauthorized use by an owner of plans and specifications drawn by him, is one upon which there appears to be little authority in the books. The point was, however, passed upon in the recent Connecticut case of Johnson & Burns, Inc., vs. Hayden, 119 Atl. 50, and, because of the paucity of authority directly on the question, this decision appears to be one of interest and value to architects in general.

In this case the defendant, the owner, entered into a contract with the plaintiff whereby the latter was to draw the plans and specifications for a house, and to supervise its erection in case the defendant decided to build. The consideration moving to the plaintiff for such services was to be 5 per cent. of the cost of the house, less $310 which was to be credited on the total bill.

The plaintiff made the preliminary plans, obtained data for specifications, obtained estimates, etc., after which the defendant informed the plaintiff that as the estimates showed the house would cost more than $12,000, he could not build. The defendant thereupon informed the plaintiff that he was through with its services as an architect, and desired to have a settlement for the services rendered. After some negotiations, the plaintiff accepted the sum of $50 as settlement in full of all claims under the contract.

Now, it appears, that the defendant before returning the original plans to the plaintiff, after the settlement noted above, had photographic copies of the plans made. Thereafter the defendant employed another architect, and gave him the photographic copies of the plans to be used in the making of plans which were substantially the same as the plans made by the plaintiff. The house was thereupon erected in accordance with the plans so prepared at a total cost of $14,430.

Thereafter the plaintiff brought the instant action against the defendant

for damages for an alleged breach of contract. The plaintiff set forth that it had accepted the sum of $50, as an accord and satisfaction of all claims under the contract, but claimed that the settlement was obtained by the fraudulent representations of the defendant. The trial in the lower court resulted in a judgment in favor of the defendant. The plaintiff prosecuted an appeal to the higher court, where in passing upon the effect of the untrue representations of the defendant, in obtaining the accord and satisfaction made with the plaintiff, it was, in part, said:

"The defendant's representation that he was through with plaintiff's services as an architect was the inducement for the making of the accord and satisfaction. The representation was untrue, since at that time the defendant was using and purposed using plaintiff's plans in the making of plans for a house and in the construction of same. * * * The defendant made this representation for the purpose of inducing the plaintiff to act upon it. The plaintiff relied upon this representation to his prejudice. This constituted a fraud on the plaintiff, and voided the accord and satisfaction. * * *

"The defendant's motive in refraining from making the disclosures was intentional, and arose from his desire to get rid of his contract with the plaintiff and at the same time to avail himself of the fruits of his labor. When the defendant secured the acquiesence of the plaintiff to the accord and satisfaction by these means he took an unfair and unconscientious advantage of the plaintiff. * * * And he obtained an unfair settlement to the prejudice of the plaintiff, which cannot be permitted to stand.

"Unquestionably the defendant had the right to withdraw from his contract with plaintiff upon paying him just damages for his breach of the contract, but he could not accomplish his end by overreaching the plaintiff. An accord and satisfaction obtained in this way will be treated as wholly nugatory because in law obtained by fraud. * * *"

Following the foregoing statement of the invalidity of the accord and satisfaction relied upon by the defendant, the court directed its attention to the question of the measure of the plaintiff's damages. In this connection it was, among other things, said:

"As a result of the prevention of its performance of its contract with the defendant, the plaintiff was entitled to recover compensatory damages for the loss it had sustained by the defendant's breach. * * * This included, not merely for the value of the services the plaintiff had rendered, but in addition such benefit to it to have made the completed plans and specifications and to have supervised the construction of the house according to its own plans. This item should be arrived at by ascertaining what the cost and the expense of the completion of the contract would have been to it, and then the difference between the contract price, less the $310 agreed upon, and this item of cost and expense should represent the profit accruing to it on account of the breach of the contract by the defendant. * * *"

In conclusion the court set aside the judgment rendered below in favor of the defendant, owner, and ordered judgment to be rendered in favor of the plaintiff in accordance with the rule announced above for ascertaining the damages. Holding, as outlined in the opinion, that the accord and satisfaction relied upon by the defendant was of no avail because of the manner in which it had been procured, and that the plaintiff was entitled to damages for the breach of the contract by the defendant.

Roof Panel Tests Under Way.—Mr. S. H. Ingberg, of the U. S. Bureau of Standards, reports the equipment practically complete for the series of brand tests of shingle roofs and prepared roofings which are to be conducted for the purpose of determining the fire resistive qualities of roof coverings and thus either confirm or correct the statements in the report of the Building Code Committee of the Department of Commerce in the pamphlet entitled "Recommended Minimum Requirements for Small Dwelling Construction" to which shingle manufacturers have taken exception on the ground that the data and recommendations were unfairly prejudicial to wooden shingles.

The tests will probably run over a period of two months. Fire brands weighing 5, 25 and 100 grams, made in the form of a grid, will be used.

[From The National Lumber Bulletin of August 7th.]

The Architect as a Contractor

Viewpoint of Contractor Set Forth in Address Before Southern California Chapter, American Institute of Architects

By J. C. EDWARDS

President Southern California Chapter, Associated General Contractors

From the subject which has been given me, it would appear that you, gentlemen, as architects, have awakened to the fact that there is a growing tendency to depart from what has heretofore been generally recognized as the proper procedure in construction—that of an owner commissioning an architect or an engineer, and he, in turn, letting a general contract by the competitive bid method.

This procedure is well established and sound and, if the principles involved therein are adhered to, there is no occasion for nor will there be any departure therefrom.

There is no denying the fact, however, that owners, architects, and contractors are departing from this procedure; and it necessarily follows that their departure is the result of a belief that by so doing they can better accomplish their purpose.

It is to be expected that my viewpoint of the situation is from the standpoint of a contractor, or perhaps I should say from a group of contractors, as I am speaking for the Southern California Chapter of the Associated General Contractors, and I desire to say here that our association deems it a privilege and an honor to be given the opportunity of addressing you on this subject.

Why do some owners, architects, and contractors feel that their purposes can better be served by a departure from the regular procedure?

In so far as the owner is concerned there is only one reason—he is made to believe that by so doing he is increasing the purchasing power of his dollar.

Generally speaking, this is not true. Whether the departure be along the pathway of day-labor methods, percentage contracts, fixed-fee contracts, segregated contracts or what not, the owner's interest will not, in the long run, be as well served by any of them as by a lump-sum form of contract in which the contract price has been determined by the taking of competitive bids.

I can only assume as to why the architect ventures a departure. It may be due to the influence of the owner. It is probably very often due to the additional fee he receives, and just as often because he feels that by so doing he will obtain a more satisfactory execution of his plans and specifications.

A contractor's reasons are many, some of them fancied and some of them real. A goodly number have no foundation whatever, and these are generally the result of his lack of appreciation of the obligation he assumes by the signing of a contract.

I intend to be very frank and name a few of the real reasons why contractors, who feel themselves capable, encroach on the architect's field.

The construction industry, of which we are both such a vital part, is now conceded to be the second largest industry in the country, second only to agriculture. There has been a decided change in the personnel of the general contractors in that industry during the past 20 years or even during the past 10 years. Improved methods are definitely eliminating the rule-of-thumb contractor, and the contractor of today feels that he is entitled to and should receive the same recognition as the architect or engineer.

Your profession has permitted commercialism to gain such a foothold that, in many cases, completeness of plans and specifications is sacrificed in order that more of the fee may be retained as a net profit. Where this is done controversies arise, extras are claimed, and both owner and concontractor are dissatisfied.

The thing that makes government red tape on construction work bearable is the wonderful completness of the plans and specifications and the exactitude with which one can determine the volume and kind of work to be done.

The custom of calling for such a multitude of alternate bids is not looked on with favor by the contractor. He feels that it is part of your service to the owner to predetermine the volume of work to be done and the kind of materials to be used.

Contractors feel that in many cases bids are requested and their time consumed in preparing estimates on work, when the architect knows there is not even a remote possibility of the

work going ahead; and it is a very common occurrence for a contractor to submit a proposal to an architect and for that proposal to be held for a month or more without being accepted or rejected, the contractor being unable to obtain any information regarding same. This is obviously unjust and should not be continued if it is your intention to recognize the service rendered to the industry by the contractor.

Draw your contracts so as to show fairness to both parties concerned, the owner and the contractor. Insert an arbitration clause in them so that honest differences may be settled out of court. This may be working a hardship on our friends, the attorneys, but nevertheless it is a most satisfactory way of adjusting disputes.

In your contracts and specifications avoid the shifting of responsibility. I have seen contracts based on specifications which provided that the contractor was to assume all responsibility for plans and specifications complying with city ordinances.

Conditions such as I have mentioned have a tendency to create a desire in the contractor to undertake himself the architectural service necessary to a construction project, and it is with increasing frequency that you hear of it from the larger contracting firms.

Please do not think for one moment that I fail to appreciate the fact that in many instances contractors have, by their unsatisfactory methods, driven the architect to seek a method whereby they might be eliminated.

It is necessary, however, that we tell you our troubles and you tell us yours if anything is to be done to check this tendency to encroach on one another's field.

There never was a truer saying than this: "A man who is his own attorney has a fool for a client." The principle is applicable to construction. We each have a distinctive service to perform and I doubt very much the ability of either of us to successfully assume the other's position.

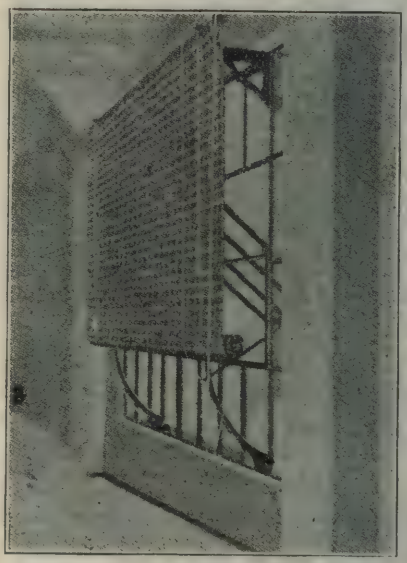
Our association will heartily endorse any effort on your part to eliminate the undesirable man in the business, because by so doing we both will be rendering a really honest service to the public. Unless such a service is rendered there is no justification for the existence of your, ours, or any similar organization.

New Type of Ventilating Shade for Center Swing Sash

From The American Builder for July

The center swing steel sash so popular in the fenestration of various types of buildings no longer presents any obstacles to proper shading against too strong or hot sunlight.

A manufacturer is producing a shade which is applied direct to the steel sash, eliminating the expensive and troublesome boring of the concrete or brick walls, and whose construction of stained wood strips,



Shade in Place Over Tilting Sash Window.

twine-woven, tend toward easy operation and lasting qualities over a long period of use.

Naturally, a shade to be properly considered as such must be of a type which does not interfere with the ventilator, even while it shields against the light. Its lower portion must be out of the way of the workers passing by, and out of the way of possible flapping against machinery. The shade illustrated is suspended from a bracket attached to the steel ribs, and is automatically brought in flush against the wall at the base of the sash.

Some Considerations in the Design of Truck Garages

Dimensions of Trucks, Floor Space and Head Room, Structural Arrangements, and Variety of Trucks to Be Anticipated

The Ramp Buildings Corporation, 115 Broad St., New York City, specialists in the design of commercial garages, have furnished the information from which the following is an excerpt:

In laying out a garage for trucks, it is essential to have information regarding truck dimensions. The figures of interest of course are the over-all length, width and height.

Below are some typical truck dimensions. The list is not complete, as regards makes, but the variety of sizes is sufficient for all practical purposes.

	Ton Capacity	Height	Width	Length
Vim	½	7 ft. 8 in.	5 ft. 1 in.	13 ft. 1 in.
Reo	¾	7 ft. 10 in.	5 ft. 3 in.	15 ft. 2 in.
Ranier	¾	8 ft. 0 in.	5 ft. 6 in.	16 ft. 2 in.
Federal	1	8 ft. 0 in.	5 ft. 5 in.	17 ft. 11 in.
Mack	1½	8 ft. 8 in.	5 ft. 8 in.	18 ft. 10 in.
Maxwell	1½	8 ft. 3 in.	5 ft. 10 in.	16 ft. 11 in.
Packard	1½	8 ft. 6 in.	5 ft. 7 in.	17 ft. 7 in.
Autocar	2	9 ft. 5 in.	5 ft. 10 in.	13 ft. 6 in.
Federal	2	9 ft. 4 in.	5 ft. 4 in.	15 ft. 5 in.
Mack	2	9 ft. 4 in.	5 ft. 8 in.	18 ft. 0 in.
Packard	2	9 ft. 2 in.	5 ft. 9 in.	19 ft. 1 in.
Ranier	2	9 ft. 2 in.	5 ft. 3 in.	19 ft. 6 in.
Federal	3	10 ft. 0 in.	7 ft. 2 in.	20 ft. 2 in.
Mack	3	10 ft. 0 in.	5 ft. 8 in.	20 ft. 3 in.
Packard	3	10 ft. 0 in.	6 ft. 9 in.	21 ft. 1 in.
Packard	4	10 ft. 10 in.	6 ft. 11 in.	21 ft. 1 in.
Federal	5	11 ft. 1 in.	7 ft. 6 in.	22 ft. 2 in.
Mack	5	11 ft. 1 in.	7 ft. 8 in.	20 ft. 3 in.
Packard	5	10 ft. 11 in.	7 ft. 2 in.	21 ft. 1 in.

In using this table, the reader may fall into serious error unless he fully understands just how the table should be used. In the first place, the over-all widths of the trucks mentioned were obtained from manufacturers' specifications. The width is always the same for any particular make and model, but this does not hold true for the over-all height and length. These two figures are determined by the body builder, and it should be remarked that truck bodies are usually built locally and the truck manufacturer has no control over the body dimensions. Because of this situation, it is correct to say that a 3½ ton Federal Truck, for example, has a width of 7 ft. 2 inches, but it is impossible to say what length or height it will be, because these things depend upon the kind of body fitted to the truck. If the sides of the body are low, the total height of the truck may not be over 7 ft. On the other hand, if the body with high sides is fitted, the height may even exceed 10 ft. The all-over length of this chassis is 224 inches, but nearly all truck bodies overhang the rear end of the chassis to some extent. The exact amount depends upon the body builder. In this case it is assumed that the body will overhang the chassis 18 in., and therefore the maximum over-all length of the truck is assumed to be 20 ft. 2 in.

The height and length in the table herewith must therefore be considered as maximum figures. The height of the truck probably will be 2 or 3 ft. less than the figures stated.

There are two ways of laying out a truck garage. One is to assume a single average truck size, and the other is to assume two or three truck sizes—say, small, medium and large. At least 50 per cent of the trucks in use are delivery cars and the like, and are no larger than passenger cars. These may be termed small trucks and a space 6½x15 ft. is sufficient for parking one of them. This figure is the same as that usually employed in laying out passenger car garages.

About 40 per cent of all trucks in use are of less than 2-ton capacity but in excess of the passenger car size considered in the preceding paragraph. On the average these will fit very nicely into a space 7x18 ft. The remaining 10 per cent of trucks will require a space about 7½ or 8x20 ft. From these figures it is plain that if the garage is designed for a single average-size truck, the size should be about 7x16 ft.

But the same figures cannot be applied to every truck garage. A truck garage in one neighborhood may cater largely to three and five ton trucks, and in another neighborhood to delivery cars. Some information regarding the character of the trade must be obtained before the garage building is designed. In many cases it is possible to obtain an extremely accurate analysis of the size of trucks used by prospective garage customers.

The problem of laying out a truck garage is still further complicated by the fact that some of the floors may be used for passenger cars and other floors for trucks.

In any case, it is desirable to obtain an extremely economical layout regardless of what the demands are. The fact is not generally realized that in a great many garage buildings it is possible to arrange the columns in such a way that in one direction economical storage for passenger cars and small trucks may be obtained, while economical storage for medium and large trucks can be obtained by arranging them at right angles to the arrangement that would be used for small trucks and passenger cars. This idea of arranging the columns so that cars can be parked more than one way is not only applicable to large buildings but frequently to small ones, and it happens that it works very well in buildings 60 ft. wide.

When it is impossible to arrange columns satisfactorily so that in one direction the space is suitable for passenger cars, and at right angles is suitable for trucks, it is usually best to use some four-car bays instead of the more ordinary three-car bays, for the reason that a three-car bay is only suitable for housing two large trucks, whereas a four-car bay will house three large trucks. This results in a considerable saving of space.

A net head room of 8 or 8½ ft. is sufficient for the general run of medium and small size trucks while a few of the very largest trucks with the very largest bodies will require a net head room of 11 ft., and if the occasional large truck is to be accommodated, a net head room of 12 ft. will be required. The net head room for medium trucks should be about 10 ft. In most cases a satisfactory solution of the problem may be arrived at by making the net head room of the first floor 11 or 12 ft., and the net head room of the upper floors 8 ft. If there are several floors above the first floor, it may be advisable to make the net head room of the second floor 9½ or 10 ft.

Timely Subjects Discussed and Acted Upon at Midsummer Conference of Ohio Builders Exchanges

The Midsummer Conference of the Builders Exchanges of Ohio which was held at Cedar Point Monday, July 23rd, was given over mainly,

1. To a review of the status of the Building Industry of the State from the standpoint of legislation recently enacted and to plans for cooperating with other state agencies in bringing about the passage of the Constitutional Amendment next November whereby the present Open Liability will be enacted.

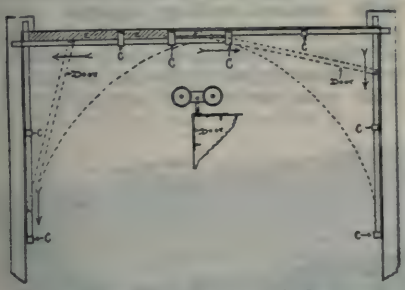
2. To a discussion of the proposed program of the newly created State Board of Building Standards. In this connection a Committee was appointed with the power to select from a list of available men a suitable representative of the Builders of the State and recommend his name to Governor Donahey for appointment on the Board. The Committee met after the Conference and agreed on Mr. John Clemmer of Akron, Ohio, and Governor Donahey was good enough to name Mr. Clemmer on the Board.

3. To a discussion as to the advisability of the State Association of Builders Exchanges cooperating in an effort to centralize in one State body all the different groups of Builders in the State. It was the consensus of opinion that the new Safety Code together with the new status of the law relating to injured employees since the recent Hannah Fender Case decision and the possible new status of the Compensation Law next year with its penalty feature, all combine to make it important that the Builders Exchanges, General Contractors, Building Supply Dealers and all groups directly connected with the Construction Industry affiliate to further and protect the interests of the Construction Industry of the State.

Garage Door Arrangement

From The American Builder for July

Many of the modern garage requirements cannot be readily satisfied by the common methods of hanging doors. Garage doors demand special consideration, and illustrated is an equipment specially designed and which is used quite extensively on public and private garage entrances.



Plan of Doors and Diagram of Movement.

The two edges of the door are hung independently by a swivel hanger, one mounted in a trackway over the opening and the other in a trackway along the side wall. In closing these doors go snugly up against the casings and are practically as tight as a swing door. When open they stand back against the side wall. The tracks cross at the center (side track under) and each enters the wall about four

Swivel Hanger With Vertical Adjustment

inches to provide space for the hanger trucks inside. For double doors the front track is in sections, one back of the other, so that the doors overlap each other at the center in closing. This gives room in the independent trackways for the hanger wheels which project well beyond the door edges.

A tight job is obtained however, by filling in behind the track as indicated and properly arranging the jamb and sill for this door. The hangers have vertical adjustment, and have hardened ball bearings, and are made in two sizes, for a door weighing up to 350 pounds, and a door weighing up to 1000 pounds, respectively. Doors may be hung in pairs also by this system, as illustrated in the diagram. It is particularly useful where the opening is wide, and the door or doors must be kept inside the building instead of being opened out.

Oilproofing Concrete Tanks

From London Times Trade Supplement.

Although concrete tanks can readily be made waterproof and suitable for the storage of some varieties of oil, without the use of special coatings, it is not easy to render them impervious to light oils, distillates, and acids generated in vegetable oils. With the object of finding some material capable of giving better and more permanent results than those which have hitherto been tried, Professor Marcusson of Berlin was led to undertake a long series of experiments and tests, and the outcome is an artificial pitch, produced by the condensation of formaldehyde with phenol, and claimed to be capable of forming a lining which complies with all practical requirements.

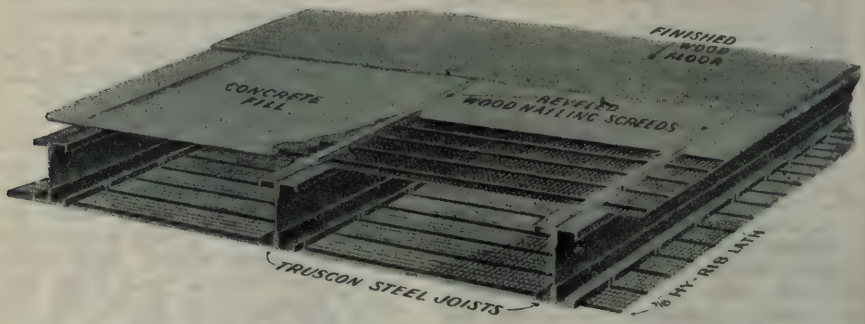
The product in question, designated "margalit," has the consistency of molasses and is applied with a brush, like paint. As it rapidly becomes heavy and sticky, it is kept in small pots into which the brush is dipped, and small quantities of alcohol are added from time to time to thin down the material. The first coat should be as thin as possible, covering the whole surface so as to fill all pores, the second coat being added a day later, and a third coat the next day, on very rough surfaces. Professor Marcusson states that after one week the concrete becomes absolutely oiltight, the margalit changing into an insoluble substance by oxidation and polymerization. Tanks lined thus are stated to have proved impervious to fuel oil, benzine, lubricating oil, linseed oil, cottonseed oil, and cod-liver oil, but it should be noted that the lining is attacked by liquids such as creosote and alcohol.

Steel Joists

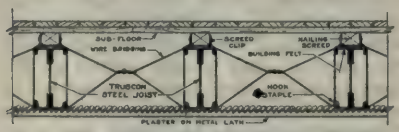
The two cuts herewith illustrate the use of light steel joists now being made by the Truscon Steel Company of Youngstown, Ohio. The advantage of this material lies in the substantial, non-combustible construction which it furnishes at a cost much below that of ordinary structural steel. The manufacturers have just issued a 32 page, profusely illustrated volume entitled "The Steel Joist Data Book" in which very full information is given on the properties and uses of these joists. It is stated therein that floors of this construction weigh from 40 per cent to 70 per cent less than do other fireproof floors. Regarding fireproof qualities the following statement is made:

"Structural steel shapes, because of their process of production, have their fibres distorted in their manufacture. When heat is applied, around 700 degrees, the internal stress is released and the steel member becomes distorted and twisted in shape. The process of manufacture of Steel Joists causes no internal stress, with the result that ample strength is available up to temperatures around 1000 degrees to 1200 degrees, with no tendency to twist or distort. Repeated fire tests have proven that ⅞ in. of cement ceiling plaster will protect Steel Joist Construction against temperatures of as high as 1700 degrees, such conditions developing less than 550 degrees around the joists. The fireproofness of Steel Joists has been developed not only in tests but in actual fires in comparison with other constructions."

The sectional perspective shows a wooden floor laid on a concrete filler with wooden nailing screeds. The right section shows an all-wooden type of floor. Numerous solid concrete and other types of floors, as well as roof construction with the joists as purlines, are illustrated in the data book.



Truscon Steel Joist Construction With Wood Floor Finish. ⅜-In. Hy-Rib Lath for Floor and Ceiling.



For Joist Spacings Up to 24 inches

Arrangement for Wooden Floor and Joist Spacings Up to 24 Inches.

Pittsburgh Zoning Ordinance Passed by Council

The Zoning Ordinance prepared by the City Planning Committee and amended by City Council passed that body on July 30 by a seven to one vote.

The limit to the height of buildings in the downtown section is 265 feet which is about the height of the William Penn Hotel.

The ordinance divides the city into five classes; namely, A. and B. residential. Heavy industrial, light industrial and commercial.

It is not considered that this ordinance is absolutely perfect. It will be necessary to make slight changes from time to time, but it is conceded that its passage will be a great benefit to property owners in all zones, but more particularly in the residential districts.

Monthly Statistics of the Building Industry

The accompanying tabulations are taken from the Survey of Current Business, a publication of the U. S. Department of Commerce. They show (1) the building contracts awarded by thousands of square feet, and thousands of dollars, (2) the index numbers for building contracts awarded, (3) the building material price index for frame and brick houses, (4) the cost index for constructing factory buildings, and (5) the index numbers of wholesale prices for structural steel, iron and steel, composite steel and composite finished steel.

The figures on building contracts are based on data compiled by the F. W. Dodge Co., covering small towns and rural districts as well as large cities in 27 northeastern states. Prior to May, 1921, the building figures covered 25 northeastern states and the District of Columbia. The states are those north and east of, and including, North Dakota, South Dakota, Iowa, Missouri, Tennessee, and Virginia, together with portions of eastern Kansas and Nebraska. Beginning May, 1921, North Carolina and South Carolina were added to the list, but this addition is stated to have little effect upon the total.

The price indexes for frame and brick houses are from the U. S. Department of Commerce, Bureau of

Year and Month	Grand Total Building Contracts: Thousands of sq. ft.	Grand Total Building Contracts: Thousands of dollars	Index Numbers: Sq. ft.	Index Numbers: Value	Building Material Price Indexes: Frame house	Building Material Price Indexes: Brick house	Cost Index: Factory building costs	Wholesale Prices: Structural steel beams (Pittsburgh)	Wholesale Prices: Iron and steel	Wholesale Prices: Composite steel	Wholesale Prices: Composite finished steel
1913 monthly av.	.....	$71,475	.....	33	100	100	.....	100	100	100	100
1914 monthly av.	.....	60,020	.....	28	.....	.....	100	83	87	88	86
1915 monthly av.	.....	78,341	.....	36	.....	.....	.....	93	94	95	92
1916 monthly av.	.....	113,082	.....	53	.....	.....	.....	177	154	163	161
1917 monthly av.	.....	134,086	.....	63	.....	.....	.....	269	266	259	252
1918 monthly av.	.....	140,770	.....	65	.....	.....	.....	202	215	220	213
1919 monthly av.	46,683	214,990	100	100	.....	.....	.....	174	191	193	188
1920 monthly av.	33,491	211,102	72	98	.....	.....	.....	187	249	211	222
1921 monthly av.	32,267	196,648	69	91	.....	.....	179	131	155	156	152
1922 monthly av.	47,745	279,410	102	130	182	186	170	115	144	134	134
1921											
January	15,513	111,608	33	52	.....	.....	.....	.....	.....	.....	.....
February	16,807	100,677	36	47	.....	.....	.....	.....	.....	.....	.....
March	26,709	164,092	57	76	.....	.....	.....	.....	.....	.....	.....
April	34,494	220,886	74	103	.....	.....	.....	.....	.....	.....	.....
May	35,751	242,094	77	113	.....	.....	176	146	165	170	166
June	35,738	227,711	77	106	.....	.....	172	146	159	165	159
July	31,717	212,491	68	99	.....	.....	167	139	145	153	148
August	35,246	220,721	76	103	.....	.....	161	128	137	144	141
September	41,702	246,186	89	115	.....	.....	160	123	134	138	136
October	40,436	222,480	87	103	.....	.....	157	116	135	134	134
November	37,318	192,311	81	89	166	173	154	106	132	133	128
December	35,272	198,518	76	92	173	179	153	99	129	130	127
1922											
January	30,261	166,320	65	77	174	179	152	99	127	126	124
February	30,061	177,473	64	83	169	174	152	99	125	124	121
March	51,957	293,637	111	137	169	173	152	96	125	122	122
April	58,146	353,162	125	164	168	172	152	99	131	126	125
May	59,639	362,590	128	169	173	176	157	106	139	127	127
June	60,526	343,440	130	160	178	181	169	106	140	129	130
July	51,705	350,081	111	163	181	184	171	109	142	130	131
August	54,019	322,007	116	150	189	193	174	116	151	137	138
September	44,275	271,493	95	126	193	197	190	137	166	146	146
October	46,806	253,137	100	118	196	199	192	141	166	149	148
November	46,946	244,366	101	114	196	201	192	136	160	149	146
December	38,603	215,213	83	100	192	198	192	132	154	149	147
1923											
January	38,947	217,333	83	101	195	199	192	132	156	151	149
February	41,611	229,938	89	107	198	201	197	139	162	158	157
March	64,920	333,518	139	155	209	209	197	146	179	165	163
April	64,527	357,475	138	166	206	209	204	.....	.....	.....	.....
May	60,430	374,400	129	174	212	214	204	.....	.....	.....	.....

Standards, Division of Building and Housing and Bureau of Census, and are based on prices paid for material by contractors in some 60 cities of the United States. The prices are weighted by the relative importance of each commodity in the construction of a 6-room house.

The index number for constructing factory buildings is furnished by Aberthaw Construction Co., and is designed to show the relative changes in the cost of constructing a standard concrete factory building. The company believes that the year 1914 gives a normal base and that July, 1920, with an index number of 265, represented the peak of costs.

The index numbers of wholesale prices for structural steel, etc., are obtained as follows: The prices for structural steel beams are the average of weekly prices from the U. S. Department of Labor, Bureau of Labor Statistics. The figures for iron and steel are the average of weekly prices compiled by the Iron Trade Review on the following 14 products: Pig iron, billets, slabs, sheet bars, wire rods, steel bars, plates, structural shapes, black galvanized and blue annealed sheets, tin plates, wire nails, and black pipe. Pig iron average in turn is aver- of 13 different quotations.

The figures for composite steel are compiled by the American Metal Market and represent the average price per pound of steel products weighted as follows: 2½ lb. bars, 1½ lb. plates, 1½ lb. shapes, 1½ lb. pipe, 1½ lb. wire nails, 1 lb. galvanized sheets, and ½ lb. tin plate.

The composite price of finished steel products is compiled by the Iron Age. It includes: Steel bars, beams, tank plates, plain wire, open-hearth rails, black pipe, and black sheets. These products, according to the Iron Age, constitute 88 per cent of the United States output of finished steel.

Raymond Concrete Pile Co. Opens Office in Los Angeles.—The Raymond Concrete Pile Company has recently opened a Pacific Coast office in the Washington Building, Los Angeles, California. Mr. O. C. Struthers, formerly with Pratt & Thompson, General Contractors, Kansas City, will be in charge.

Some Ideals in Planning for New York

The following from the pen of the late Charles D. Norton, chairman of the "Committee on the Regional Plan of New York and Its Environs," promoter of "The Burnham Plan" for Chicago, and otherwise leader in city planning activities, states some of the ideals for which plans exist.

Let some Daniel H. Burnham do for this immense community what Burnham did for Chicago and its environs; spend the best years of his life studying all the varied possibilities which lie within an area so infinitely attractive physically, with a population so dense, a commerce so great—let him show how the isolated Palisades Park, with its thirty square miles of wilderness, and the east side of New York only six miles away, with its million and a half of tenement dwellers, may be brought nearer together; how the commuters of small incomes in Jersey or the Bronx may more easily reach the beaches; how the merchants and the railroads and the public authorities may combine to reduce the cost of handling goods and maintain the supremacy of this port; where markets and parks may be created. Let him demonstrate with unfailing logic where the civic centres of this vast population really are and how they should be developed and embellished. In short, let him make a big, daring, imaginative plan such as George Washington and his French engineer L'Enfant had the courage to make for the City of Washington 115 years ago—and New York will not fail to recognize and adopt her city plan.

Metal Lath Specifications.—The Associated Metal Lath Manufacturers, 123 W. Madison Street, Chicago, have decided to confine their products to ten different weights, and in connection with The American Specification Institute, they have issued a series of 17 specifications for the erection of metal lath for various uses. The book consists of 16 pages, fully illustrated with details.

Equipment Review

QUARTERLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.

221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*

LEWIS S. LOUER, *Vice-President and General Manager*

New York Office: 904 Longacre Bldg., 42d St. and Broadway

RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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Vol. LX. CHICAGO, ILL., AUGUST 29, 1923 No. 1

Equipment

Equipment grows daily in importance to constructors in every field and so again claims a quarterly issue of Engineering and Contracting. The displacement of hand labor by machines is an evolutionary process—its rate depending upon a number of controlling factors, most conspicuous among which, and perhaps most important, are the availability and cost of labor.

Neither cheaper nor more plentiful labor than we now have is to be expected in this country. In fact sober anticipation points to exactly the reverse of these conditions, and so to continued developments and extensions in the use of equipment. Without doubt many sorts of work on which machinery is still generally considered as a means of saving expense and increasing profit will soon cease to be economically possible by hand methods.

Developments come for the most part as improvements in existing machines, and only rarely as novel or surprising inventions. Wherefore the reader will find many old friends in the pages following; but if he looks closely he will see that like the better sort of human friends, they are steadily improving. Novelties he may find also, but we believe only meritorious novelties. Whether the development is an innovation, a radical improvement, or a betterment in detail only, it is worth while to the equipment user.

The Index to Engineering and Contracting

The index to this paper is sent only to subscribers who are known to desire it. If you wish to receive the index regularly, and have not heretofore notified us to that effect, write to our subscription department, and they will very gladly add your name to the list to which the index is sent twice each year.

The index to Volume LIX, January to June 1923, is now off the press, and has been mailed to all our standing list. It will be sent promptly to all others who will notify us of their desire for it.

Recent Developments in Construction and Engineering Equipment

A New Gasoline Dipper Shovel

A gasoline driven power shovel operated entirely with gears and shafts, is the latest improvement in this type of machinery, announced by the Orton & Steinbrenner Co., Manufacturers of cranes, shovels, and buckets, of 608 So. Dearborn St., Chicago, with factory at Huntington, Ind.

The steam driven type of shovel has long been in use and has proved very successful. During the past few years, on account of the development of the gasoline motor, various schemes have been put forward, attempting to adapt this form of power to a dipper shovel. The greatest difficulty in the adaptation of gasoline power to shovel use is in the arrangement necessary for the reversible crowding motion of the dipper stick. With steam operated shovels, this is accomplished by means of a small steam engine geared directly to the shipper shaft. But with the gasoline or electric type, this method was not feasible, and other means had to be developed.

Orton & Steinbrenner Gasoline Shovel.

The movement is secured in the new Orton & Steinbrenner machine with a gear drive which is simple and has a small number of parts. At the bottom of the boom connection is a shaft carrying double steel bevel gears and bronze friction clutches. This shaft is concentric with the pivot of the boom and consequently being independent of its position, the boom can be used at any angle to suit the exigencies of the work.

Along the boom is a steel shaft carrying two bevel pinions, one meshing at the bottom with the gears on the horizontal shaft, and the other at the top meshing with gears on a countershaft located about half way up the boom. This latter shaft carries a brake and "slip friction," and is geared directly to the cast steel rack on the dipper stick.

The hoisting mechanism is simple in construction and is in fact the same as in the locomotive cranes built by the Orton & Steinbrenner Co. for fifteen years. The simplicity of parts is also of great advantage in converting the shovel into a clam shell outfit, drag line, or skimmer rig.

The power is supplied by a heavy duty 4-cylinder "Climax" motor, which is designed with a view of economical use of gasoline.

Another feature of the machine is the flexible crawling tread. Full advantage has been taken of the experience gained in the design of tanks used in the World War. It was proved conclusively that flexibility and lubrication of the tread and tread rollers was absolutely necessary to their proper operation. These flexible treads adjust themselves readily to the ground surface, equalizing the weight of the machine and distributing it over a considerable length of tread.

On the main horizontal drive shaft are two brake wheels by means of which each tread may be operated independently or both may act together. The mechanical differential arrangement is exactly similar to that used on automobiles.

When used as a crane, the only thing required is to take off the shovel boom and attach the crane boom; the crowding frictions for operating the dipper being carried by the shovel boom and an integral part of it are removed with it. The shovel, when furnished with double drums can be used interchangeably with the crane. With the crane boom attached, any of the various types of buckets or scoops can be used, such as clam shell, drag line, skimmer scoop, or trench hoe; pile driver leads may be swung from the tip of the boom.

The Biggest Paver

The 32-E Koehring paving mixer shown herewith is the largest machine of this type so far produced. It handles batches of 34 cu. ft. each, and has a record of one mile of 18 ft. pavement in four days.

This machine is a self contained unit like the smaller Koehring mixers, and is operated by one man except when the derrick is used, in which

Koehring 32-E Paver.

case an additional man operates the power hoist and sluing arrangement.

Designed and built for the bigger jobs where adequate supplies of materials necessary to feed it continuously are available, the Koehring 32-E Paver handles the work at top speed and most effectively on the largest scale of operations.

A complete batch of 56 cu. ft. of aggregate is handled from one truck or batch box.

The charging skip, 9 to 12 feet wide, and 20 feet long, is of ample size for a truck with a full batch capacity to back into and discharge its load. When using the industrial system, a power operated derrick with power hoist and power sluing attachment quickly transfers the batch boxes containing the full batch, from the cars to charging skip.

Double sets of cables are placed on the charging skip, each one of which is sufficiently strong to hoist the load; the skip cannot drop if one cable breaks. Skip is raised in 15 seconds to an angle of 55 degs. where an automatic brake stops and holds it in charging position. An auxiliary water tank is furnished which safeguards the water supply at all times.

The Koehring Company, makers of the 32-E, is located at Milwaukee, Wis.

New Track Shifter

A labor-saving machine designed for shifting or raising track has been brought out by the Lake Superior Loader Co., Providence Bldg., Duluth, Minn. The machine is propelled and operated by a standard gasoline engine. The lifting action is obtained by means of a spud and gears. One operator drives and operates all racking and lifting motions through simple controls and standard clutches. In shifting track, the rail clamps are hooked over ball of rail and the spud is racked down with shoe between ties on side of track toward intended shift. The entire machine is then racked up on the spud, thus raising the rails and ties up on one side. The tilt of the spud then starts the whole raised mass sliding over to intended side. After reaching maximum height of lift, the leverage exerted gently slides the entire track section over to new position. The rail clamps are then loosened, machine

Track Shifter on Waste Dump on Mesabi Range

moved forward two rail lengths and operation is repeated. In lifting track the spud is racked down in center of track with no tilt. The machine, clamped to the rail, is then racked up, thus lifting the entire track section and allowing ample room for ballasting and tamping. The accompanying illustration shows the machine working on a waste dump on the Mesabi Range, where it replaced 8 men from a gang of 18. In this operation the track and ties have been lifted about 15 in.

Convertible Crane-Pile Driver

Industrial Works of Bay City, Mich., makes a pile driving equipment for use with its Type KA locomotive crane, and terms the combination its Type KA-P Crane-Pile Driver.

In this combination the Type KA locomotive crane is equipped with heavy-duty pile driving leaders and truss and forms a very powerful and

Driving Piles 30 Ft. From Track With Type KA-P Crane-Pile Driver

efficient, full-revolving railroad pile driver. It is selected in preference to regular pile drivers on some railroads on account of the full-revolving feature it offers and the unusually long reach ahead of the front axle and over the sides of the car.

The truss and leaders are similar to those used on the regular Type No. 2 and No. 4 pile drivers with battering attachment to swing the leaders for driving inclined piles. They are very strongly built to allow for crowding piles into position by slewing the crane.

As the crane may be swung through a full circle, piles may be driven from either end of the car without turning the car around. Outriggers are provided under the car body, and with these blocked, piles may be driven with truss and leaders swung at right angles to the car.

The leader truss is easily removed and a regular crane boom substituted for locomotive crane service.

A large-size vertical boiler is usually provided, but when required this machine may be equipped with a special horizontal locomotive-type boiler. Such a boiler is especially useful when the machine is required to propel for considerable distances.

This locomotive crane may be geared to travel 10 miles per hour under its own power. It is always equipped with the standard Industrial gear shifter, which allows the propelling gears to be completely and quickly disengaged for hauling over the road.

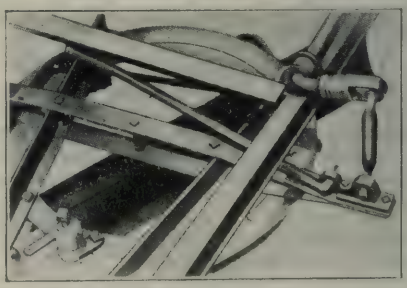
Improvements on Stockland Road Grader

Below is a top view of the circle assembly on the "Peerless Patrol Quick Lift" grader made by the Stockland Road Machinery Co. of Minneapolis, Minn. The trussing on this assembly gives a very accurate blade adjustment and a responsive control. It also removes all side strain from the draft bars.

The casting supports, upon which the circle turns, are provided with shims. As wear occurs the removal of one or more shims again restores the tight, smooth operation of the circle.

The lifting arm connections are also provided with a take-up which keeps them closely connected and smooth operating.

The trussed construction on the



Circle Assembly of Stockland Grader.

draft bars eliminates the possibility of developing play between the connecting rods and the draft bars as they are raised or lowered.

The worm gear at the handwheels is also built against wearing—both end-wear and side-wear. Shims and tightening bolts are used to accomplish this.

Truckrane on Reservoir Job

The crane here shown in the nearly completed Fairmont Reservoir at Cleveland, Ohio, was originally purchased as a model "1" Auto-Crane from The Byers Machine Company of Ravenna, Ohio. It was then a regular crane without truck mounting, but set up on some kind of a permanent foundation, electrically operated and used to hoist skips of excavated material from the tunnel carrying the mains leading up to the gate house in the basin itself. The crane was used in this service for several weeks and when that phase of the work was completed, was taken down, mounted on a trailer and gas power substituted for electricity. It then became, in effect, a standard "Truckrane." It is owned by the Peter F. Connoly Co. of Cleveland.

Byers Truckrane in Fairmont Reservoir, Cleveland, Ohio.

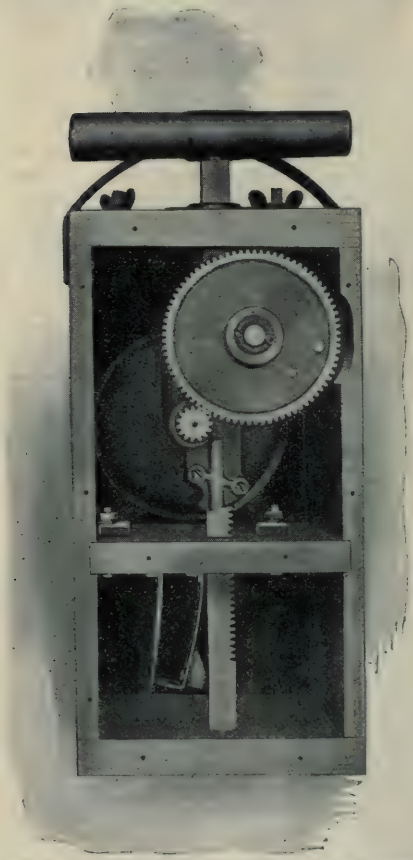
Within the Reservoir basin, the crane was first used for rehandling concrete aggregates—picking these up with clamshell as they were dumped down the side of the Reservoir from tracks and loading them into trucks to be hauled to the site of the gate house. The latter is the concrete structure shown at the right in the picture. Moving then to the site of the gate house, the Truckrane was used to hoist batches of mixed concrete, dumping into the forms. For this and succeeding work, the owners spliced an additional length of boom to the standard boom to provide the necessary height for placing the concrete and doing steel erecting which was the crane's next biggest job. The top of the gate house is approached by a roadway which is carried on two steel girders. Each of these is an I-beam 28x 14x52 ft. 8 in. long and each was placed by first sliding the beam down the bank of the Reservoir and then lifting the lower end into place by the power of the Truckrane. The owner now plans to mount the crane on a new 5-ton truck to use in general contract work. It is interesting to note that a similar operation is to be undertaken in an adjoining basin of the Fairmont Reservoir.

An Improved Blasting Machine

By N. S. GREENSFELDER

Hercules Powder Co.

During the War the Ordnance Department and Engineers Corps of the Army required a large number of blasting machines. It was soon discovered that the machine commonly



Interior of New Improved Hercules Blasting Machine.

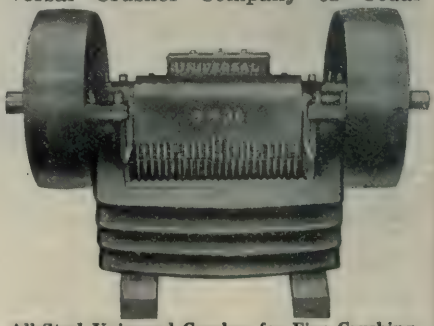
used on industrial work failed repeatedly on the battlefield. After the inability of the old type of machine to meet military requirements was discovered, the Bureau of Engineers requested electrical manufacturers to assist them in designing a machine that would be absolutely reliable and would possess sufficient reserve capacity to guarantee against failure to fire any electric blasting cap in circuits up to 100 caps. A machine that fulfilled these requirements was soon developed. It is now sold for industrial work by the Hercules Powder Co.

One of the principal advantages of the new Hercules machine is in the generator. Practically all of the old types consisted of a short-circuited, series-wound motor, in which a heavy current is built up during the stroke. At the end of the stroke, the short circuit is opened, which allows the field discharge from the generator to pass into the cap circuit. The new Hercules machine, on the other hand, has a shunt-wound generator. All of the energy of the operator is accumulated as the rack bar descends. The switch remains open until the stroke is nearly ended. At the instant of maximum amperage and voltage, current enters the cap circuit and this current is sustained for a considerably longer period than in the old type. Tests made at the United States Bureau of Standards at Washington show that even a moderate current sustained for 1/5 of a second is much more effective than a current many times higher, but which is sustained only 1/1000 of a second.

While this new machine has actually fired many more than 50 electric blasting caps, its capacity is rated at 50 blasting caps, because experience has shown that, under proper working conditions, it is not advisable to attempt to connect more than 50 electric blasting caps in one series.

Crusher for Quantity Production

The machine shown in the accompanying illustration is one of the large size units developed by the Universal Crusher Company of Cedar



All-Steel Universal Crusher for Fine Crushing.

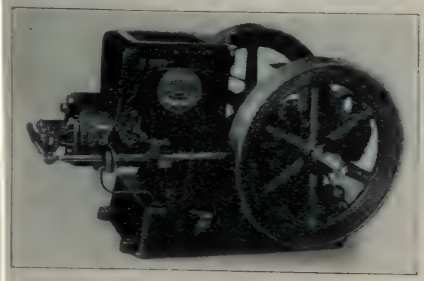
Rapids, Iowa, to supplement its long established line of medium capacity crushers.

The Universal Crusher has long been recognized as a machine which

would give a highly uniform and fine product in medium quantities, and the solution of the problem caused by the vast increase in road development and the use of concrete, was found in the construction of a machine having the same basic working principles but of larger capacity. The design shown herewith is that of the fine crushing line in sizes 8x16 in., 8x18 in., 8x24 in. and 8x36 in. These sizes together with six other large opening machines for boulders, trap-rock, granite, limestone, etc., constituting a complete line of all-steel crushers, are furnished in either stationary or portable styles, with or without elevators, of the straight or folding types. A cut-under truck provides a convenient, practical and up-to-date mounting.

New 2½ HP. Gasoline Engine

A new 2½-h. p. Model N gasoline engine has been added to the line of the Fuller & Johnson Mfg. Co., Madison, Wis. This new size, as well as their entire line of Model N engines, is stated to embody many new improvements and refinements, which have added to the durability and efficiency of the engines and at the



2½-HP. Model "N" Gasoline Engine.

same time to the operator's convenience. A new filler pipe to fuel tank as shown in the illustration has increased the ease and convenience of filling the fuel tank. A double throw switch, for giving uninterrupted service, is now standard equipment on all sizes with magneto ignition; and the new magneto mounting, in addition to being convenient is high and dry—away from oil and grease. The wide, heavy fly wheels, the heavy crank shaft and bearing give unusual strength and rigidity to the engine.

Full-Crawler Attachment for Fordsons

The Full-Crawler attachment to be used on the Fordson tractor has recently been put upon the market by The Full-Crawler Company, a department of the Geo. H. Smith Steel Casting Company, of Milwaukee, Wisconsin.

This equipment when substituted for the ordinary four round wheels of the Fordson tractor, changes the Fordson into a crawler or caterpillar tractor.

The tracks of electric alloy steel of special ground-gripping design take

Full-Crawler Fordson Pulling Road Machine.

firm hold of the surface whether it be hard or soft. The track surface which is in constant contact with the ground consists of over 1,000 square inches. Being of crawler design, the machine travels on top of the ground.

Steering is accomplished by means of brakes on the rear sprockets. These brakes are so connected with the Fordson steering handwheel that a slight turn of the wheel to either side as in ordinary steering causes one brake to tighten and the other to loosen. The track on the inside of the turn locks while the other runs freely. The Full-Crawler equipped Fordson will turn about in a 10-ft. circle, about half of the usual Fordson turning radius.

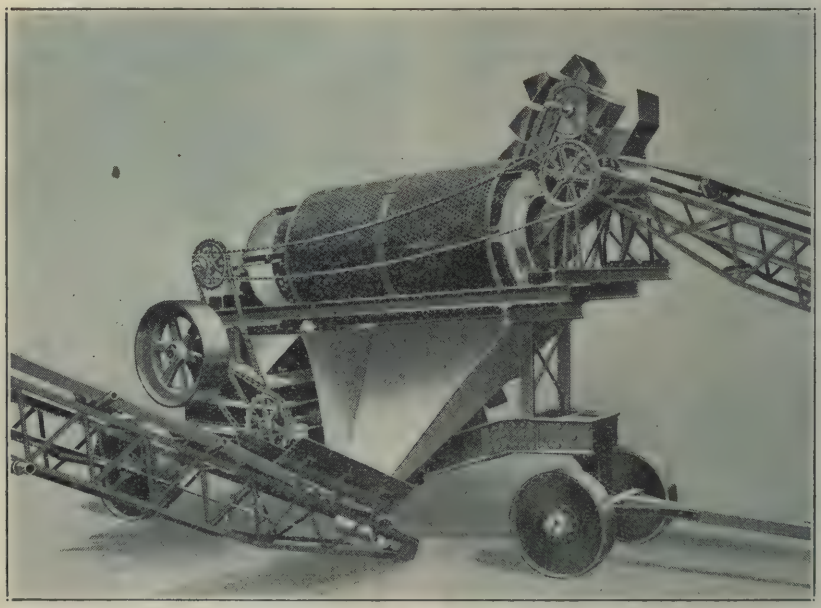
The total weight of this crawler equipment is 1570 pounds. As the four round wheels of the Fordson are removed, the additional weight added to the Fordson tractor is about 1000 pounds, making the total weight of the Fordson and the Full-Crawler amount to about 3600 pounds. This added weight helps to give better traction, yet, being spread over such a large track area, does not greatly increase the ground pressure. The Full-Crawler Fordson has a ground pressure of only 3¾ pounds per sq.

in., so that it is possible to use this equipment on very soft soil.

It is made to be used only on the Fordson tractor and is very easily attached. There are no holes to be drilled nor is any machine work necessary. No change is required in the Fordson. No reduction gears are used. The speeds of the Fordson tractor remain the same after the substitution of the Full-Crawler for the four wheels.

Compact Crusher Outfit

A "one piece crushing outfit" has been brought out recently by the Iowa Manufacturing Co., Cedar Rapids, Ia. In this outfit a No. 936 Cedar Rapids crusher is mounted on the rear end of a 1 in. 15 ft. steel 1-bear truck. Ahead of and above the crusher is mounted a screen which has a 5 in. I-beam frame, 36 in. x 8 ft. inside screen, 48 in. x 7 ft. outside screen. Inside screen of 1 in. perforations; outside 2 in., of course this is optional. On the outside of the truck frame, but fastened to it, is a 6-in. channel iron frame elevator, equipped with 14x7 14-gauge steel continuous type buckets. There also are one 30-ft. and one 35-ft. belt conveyors, equipped with 12-in. x 18-in. steel split head pulleys. Each conveyor equipped with two 40-in. x 5-in. steel wheels for portability. The 30-ft. conveyor feeds the material from the pit into the screen, where the separation is made. The screenings go down the large chute into the 35-ft. conveyor, which takes the material to the finished bin. Rejections drop into crusher, are reduced to desired size down a chute into elevator, and are returned into the screen. The power for the various units is taken off the crusher shaft by sprocket and chain drive to a counter-shaft on the truck frame, thence, by sprockets and chain to the various units.



"One-Piece Crusher Outfit."

Portable Pumper Attachment for Ford Cars

A pump attachment for Ford cars, adaptable for use in construction operations, has been brought out by the Barton Products Co., Jackson, Mich. The pump is of the well known centrifugal type, of special design, and is equipped with an open runner which makes it possible to pump water containing small sticks, gravel and mud, such as the contractor is

likely to encounter in construction work. The connections used between the pumper and the car are of simple construction and strong enough to carry the pump on the front end of a Ford, and it can be left on while driving with no danger of strain or breakage to the car, for the weight of the

Barton Attachment Ready to Attach Pump to Car

pumper is carried entirely on the frame, relieving crank shaft and motor of all strain. The first installation of the pump and attachment on the Ford requires about 1½ hours work and thereafter the pump may be connected or disconnected in two minutes. It is stated that the pumper will lift water by suction 26 ft. and has a normal discharge capacity of 250 gals. per minute with an engine speed equal to 20 miles per hour on the road. The pump is designed and built by the American Steam Pump Co., Battle Creek, Mich.

Motor Driven Power Lift Scarifier

A scarifier attachment for the Avery 10-ton road roller, designed for operation by the power of the motor,

Avery Scarifier Attachment.

has been brought out by the Avery Co., Peoria, Ill. The teeth of the scarifier are raised or driven into the ground by the motor power direct and controlled by one lever. A suitable reducing mechanism driven by a clutch on the motor crank shaft drives a crank shaft mounted under the subframe of the machine through a timing clutch. This crank shaft drives a rock shaft at the rear end of the machine through spring loaded pitman rods, which raise or lower the teeth. These springs act as shock absorbers to the mechanism. Teeth are driven into the ground by a toggle mechanism under great pressure. The tooth bar is 4 in. square steel turned down at ends for 20 in. gauge wheels. The teeth are carried in holders clamped to square bar, are adjustable as to side spacing, depth and angularity to ground. Seven teeth of 1¾ in. square tool steel, 32 in. long and pointed on both ends are furnished. All pull strains are taken on the draw bar. When teeth enter ground 9 in., they will clear 11 in. when lifted. The distance over gauge wheels is 83 in.

Barber-Greene Improve Vertical Boom Ditcher

The view below shows the latest form of vertical boom ditcher made by Barber-Greene Co. of Aurora, Ill.

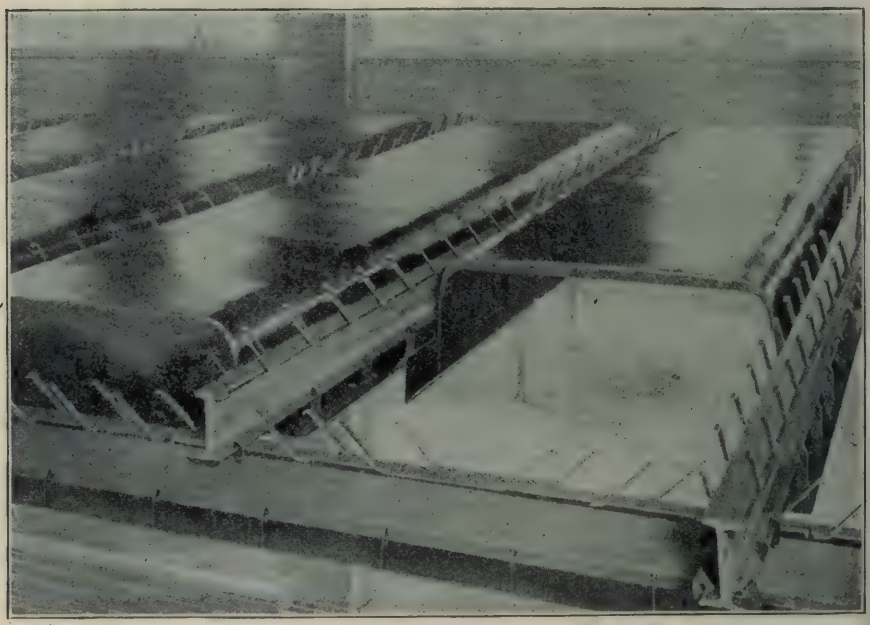
New Vertical Boom Ditcher at Work.

This carries several improvement, the most noteworthy of which is the addition of carrying shoes which aid in supporting the digging boom. These are well illustrated in the picture. They not only aid in supporting the boom, but as may be seen they aid in keeping the excavated materials from falling back into the ditch.

The machine works to a depth of 5 ft. It is mounted on the standard chassis of the Barber-Greene self-feeding bucket loader. Power is supplied by a 25 horsepower Buda engine which gives it traveling speeds of 36 ft., 72 ft. and 144 ft. per minute and a reverse speed of 42 ft. per minute.

A New Development in Reinforced Concrete Construction

A new construction that combines the self-maintaining feature of structural steel with the steel economy of reinforced concrete has come into extensive use during the past year or so. This method of reinforced concrete construction — known as Truscon-I construction—consists of a series of I-beams with the top flange sheared to form rigidly connected diagonals extending into the concrete above. The Truscon I's are thus integral with the concrete, making a unit of reinforced concrete beam and slab. A complete system of removable steel forms which are suspended from the Truscon I's is provided. The Truscon I's thus serve the double purpose of providing supports for the forms until the concrete is set and of rigid reinforcement for the completed reinforced concrete structure. The only centering is usually one upright support at the center of the span. Truscon steel floretyles are also used with Truscon I's and can be removed three times before they are permanently installed in the construction. Owing to the fact that the Truscon I's support the forms, construction can be installed on two or three floors at one time. The simplicity in placing the forms, together with their early removal, also adds to the speed of construction. In an emergency the Truscon I-beams in themselves are strong enough to carry the dead load without failure, so it is practically impossible to have a collapse with this type of construction. The carrying capacity of the I-beam by itself gives an added strength which is ordinarily not computed in the calculations. Due to the fact that the I-beams carry the dead load it is possible to remove the slab forms in a comparatively short time, thus hastening construction and saving expense.

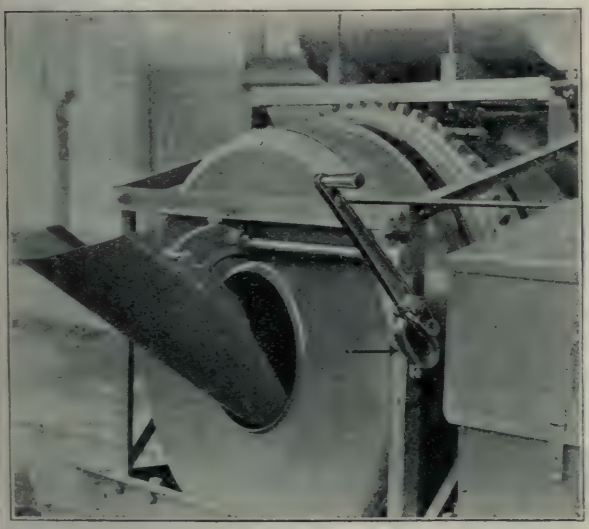


Truscon-I Construction Before Concreting, Showing Truscon I's for Beams and Girders, and Removable Truscon Steel Forms. Note that the Steel Forms are Suspended from the Truscon I's and no Other Forms are Required.

Tests made on full sized panels of Truscon-I construction are stated to have invariably developed a strength much higher than would be expected from calculations. The University of Nebraska recently completed a test in which failure was expected at about 22,000 lbs., based on conservative methods of calculation. The beam actually failed at 29,000 lb. In the tests a stress of 64,700 lb. and 58,400 lb. per square inch was developed in the steel.

A 1923 Improvement in Mixer Construction

One of the interesting improvements in concrete mixers this year is the new device used on a 7-S mixer made by The T. L. Smith Co. of Milwaukee, Wis., for operating the discharge chute. The simplicity of this mechanism is shown in the accompanying illustration. The operating lever is pivoted to a short arm that is keyed to the shaft to which the chute is attached. When the operating lever is moved, a small roller, attached to the end of the lever, follows the outline of a cam that is bolted to the mixer frame. Except for the rod which extends across the mixer to enable the chute to be operated from the other side, these few simple parts constitute the complte discharge operating mechanism. In the illustration the lever is shown in its extreme forward position. The chute is locked securely in the position for mixing and where it in no way interferes with the mixing action. Pushing the lever back moves the chute into the discharging position. In the full discharge position the chute is locked and does not have to be held. The peculiar shape of the cam provides the locking feature in each position, no other arrangement being necessary. Releasing the chute from either position is merely a part of the operation of moving the chute from one position to the other. The operator simply takes hold of the handle and moves the handle forward or backward, according to the position of the chute. By this new method the chute operates easily and quickly.



Chute Discharge Mechanism for 7-S Smith Mixer.

The Hoar Underground Shovel

A power shovel for use under ground or in surface operations where loading space, selective loading, type of carriage used or other reasons exclude the standard steam shovel or other form of loader, is manufactured by The Hoar Shovel Co., Inc., of Duluth, Minn.

With the exception of the dipper stick arrangement, this shovel is a duplicate in method of operation of the standard steam shovel. General principle and operating cycle are the same, except that the dipper stick to which is attached the dipper, is in three parts, the carriage, which slides on top of the frame, the floating dipper stick which furnishes the leverage and the double dipper stick, to which is attached the dipper proper. A leverage of 1½ to 1 insures ample capacity using small power units.

The standard No. 2 machine is designed for operation in a 7 by 7 ft. tunnel section. The shovel is 6 ft., 6 in. high, 6 ft. long and weighs 6,000 pounds. In addition to the leverage provided, a clean-up radius of 7 ft. 6 in. is assured by the use of the double dipper stick, a further advantage provided being the ability to dig below grade, possessed by no other machine, as well as the ability to follow a very uneven bottom. Mounted on trucks and built to any track gauge desired, it can be stripped in a few minutes to pass through a shaft or opening 42 in. square.

With proper haulage system provided, a capacity of 200 tons per shift in metallic ores, stone, etc., is possible and is being readily accomplished, using one operator and one helper. The

shovel is capable of loading a dead weight of 2000 lbs.

Compressed air, usually available in mining and tunnel operations, is used as power, 300 cubic feet of free air per minute, at 80 lb. pressure, being ample.

The original machines have shown a long life. One seven years old is still functioning, minor repairs having been made from time to time, but at no time has it been necessary to rebuild the shovel, nor has it been rebuilt.

1-Man Box Car Loader

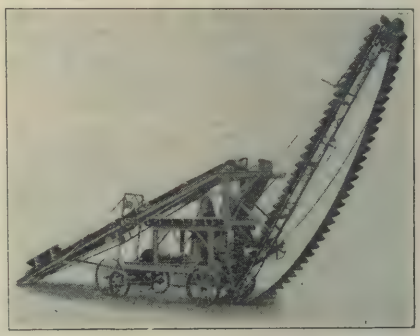
A 1-man portable belt loader designed for handling sand, gravel, crushed rock, bulk lime, cement, etc., has been placed on the market by the Ottumwa Box Car Loader Co., Ottumwa, Ia. The loader has a large front wheel with wide tread and two large rear casters, resulting in easy propelling. In fact, it is stated, due to this arrangement, one man can push the machine from place to place. Another advantage claimed for the loader is that the conveyor can be

Ottumwa Portable Belt Loader

easily adjusted—raised or lowered as desired. This makes it possible to push the machine through a low door with the conveyor end lowered. The belt speed is stated to be 500 to 1,000 ft. per minute, depending on the material to be loaded, and the capacity is about 40 cu. ft. per minute. The power required is about a 2 to 3 hp.; electric motor or gasoline engine.

Portable Gyratory Crushing Plant

A complete portable gyratory crushing plant for producing finely crushed product for road building and other purposes is illustrated. The crusher is mounted on a strong I beam frame with heavy wheels having tires of ample width. The back gear drive



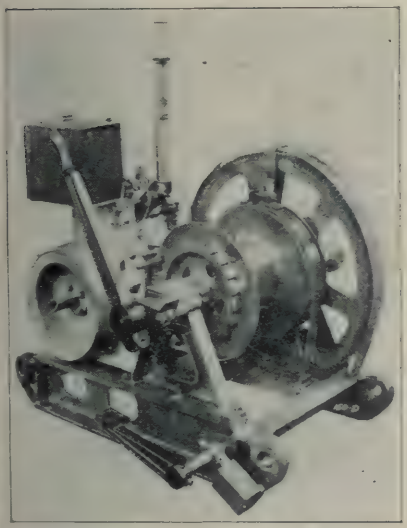
Austin Portable Gyratory Crusher With Gravel Feeding Conveyor, Grizzly Screen and Elevator.

is substantial, and so arranged that the power unit is located at right angles with the plant where it is out of the way of teams or cars bringing the stone or gravel from the pit or quarry. Numerous combinations of crusher, elevator, screen and conveyor, each adapting itself to some particular local conditions are available. The illustration shows the outfit for handling gravel. It consists of a crusher, portable gravel feeding conveyor, grizzly screen, and folding elevator. The conveyor is made in lengths from 30 to 50 ft. and has a belt 18 in. in width. The lower end of the conveyor is set in a shallow excavation and a trap built over the hopper. The gravel can then be brought directly to the trap by wagons, wheelers, drags or fresnos. The belt conveyor provides a uniform continuous feed to the crusher, thereby greatly increasing its capacity. The conveyor is raised and lowered by means of a crank and worm wheel raising device. It is easily portable by attaching its lower end to the rear of a truck or wagon. The outfits described above are made by the Austin Manufacturing Co., Chicago, Ill.

A Compact Utility Hoist

A four horsepower, non-reversing, single drum, gasoline hoist, has been placed on the market by the Clyde Iron Works of Duluth, Minnesota. The new machine is the smallest in the Clyde line, being designed for a load of 500 lbs. at single line at a speed of 155 ft. per minute.

The hoist proper is built according to the standard Clyde design, with a one-piece semi-steel bed frame of the "skid" type. The drum gear meshes directly with the motor pinion, eliminating the intermediate shaft. The drum is bronze bushed and friction driven and has a ratchet and pawl. It has a large diameter barrel which allows the rope to spool readily, notwithstanding the light load. A winch head is keyed to the drum shaft extension. Gearing is of semi-steel with machine cut teeth. The Alemite system of lubrication is used, with Alemite industrial type grease cups.



Clyde Iron Works Gasoline Utility Hoist.

The engine is a single cylinder 3⅛ x 4½ in. Le Roi, hopper cooled. An automatic governor controls the flow of gasoline, which may be shut off entirely by closing the gas valve. A high-tension magneto, carburetor with chake rod, muffler and 2½ gallon fuel tank are included among the accessories. The engine is provided with a highly efficient splash and pump circulating system of lubrication, with oil guage.

The light weight of the hoist and the skid type base make it a very portable unit which can be hauled onto a truck under its own power.

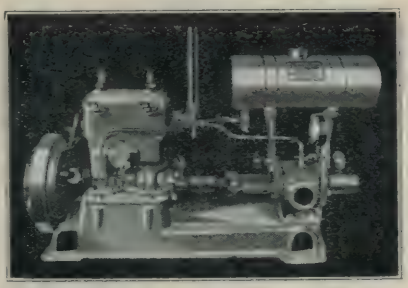
The hoist is of sufficient capacity to handle a single cage elevator and small steel work or framework jobs.

Evinrude Portable High Pressure Pump

This pump made by the Evinrude Motor Co. of Milwaukee, Wis. was designed primarily for use in fighting forest fires, but has been adapted to a wide variety of services including private water supply, small fire departments, and use on road and other construction work. Its weight of 109½ lbs. and dimensions of 11½x17x31 in. are remarkably small for its pressure and capacity. It will deliver 1500 gallons per hour at a head of 277 ft.

The pump is of the gear type, especially designed for simplicity and endurance. Extra long bearings insure freedom from wear or leakage.

The power plant is directly connected to the pump shaft by an Oldnam coupling, insuring strength and proper alignment. The engine is the well known Evinrude 4-5 H.P., two cylinder. The Evinrude Magneto—built-in-the-flywheel type, furnishes dependable ignition. Quick starting is assured when cranking. Standard equipment includes, besides the above, high grade float carburetor, aluminum base, spark plug covers, gasoline tank and necessary tools. The tank capacity is 1 1/3 gallons. Openings in the base provide easy carriage on poles.



Evinrude High Pressure Pump.

Steel Bin and Measuring Devices

On the majority of concrete road contracts in the state of Wisconsin the "batch haul by truck" method is used to transport the aggregate from the railway unloading point dumping direct into skip of the mixer, thereby, keeping the subgrade clear of all materials and eliminating the labor

Butler Measuring Hopper Dumping Into Batch Trucks.

otherwise necessary in shoveling up and wheelbarrowing into the mixer.

The accompanying view shows aggregate being discharged from a steel bin into trucks on Highway No. 12 near the city of Whitewater. This bin, made by the Butler Equipment Company of Waukesha, Wis., contains separate compartments for sand and gravel. In addition it is equipped with a set of Butler Measuring Devices as shown.

Stoughton trucks with the bodies divided into two compartments are used to haul the aggregate from the bin to the mixer. A 5-bag Koehring Mixer is used to mix concrete on the grade. The truck backs under the bin and the front compartment is loaded from the measuring devices with the correct measured amount of sand and gravel. It then moves ahead so that the rear compartment is under the measuring devices and receives the scond batch. One man on the ground operates the levers and gates on the measuring devices and loads the two batches into the truck in less than 30 seconds. The truck then stops at the cement shed and receives five bags of cement in each compartment and then proceeds to the mixer.

The man at the bin has a tally sheet to keep track of the number of batches each truck hauls. Three hundred and sixty-eight batches have been loaded from this equipment in one day.

The measuring devices can be attached to a wood bin and are adjustable for any mix on the average paving mixer.

Two New Contractors' Barrows

The Akron Barrow Co. of Cleveland, Ohio, have developed and added to their line two new wheelbarrows for fireproofing and concrete and masonry contractors. These comprise a tile barrow and a mortar and concrete barrow, both designed to move larger loads without additional strain

Mortar and Tile Barrows Developed by The Akron Barrow Co.

on the operator. Both these barrows were developed under actual working conditions. On the Union Trust Co. Building, Cleveland, the T. G. Nicholson Co. of Chicago found that their men handled one-third more tile per load with the new Akron barrow than with previous equipment and did it with less effort and greater speed. In

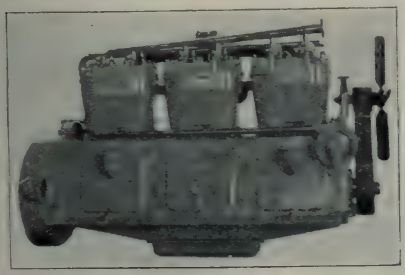
addition, the new barrows were easier on crowded runways and platforms and elevators and proved to have longer life, due to greater thickness of hardwood (full 1 in.) used in the bed and dash.

The "Jumbo" mortar barrow has capacity of full 4 cu. ft. of wet material in wheeling position, and is easily handled with that load.

Model R-6 Climax Engine

In designing this engine six 5½ x 7 in. cylinders were decided upon as fitting in best with the demand for an engine of 80 to 120 H. P., the idea being that six cylinders of not too large size would deliver a smoother and better quality of power than a large, slow speed, four cylinder engine.

The crankcase has a deep section for strength and rigidity; provides for mounting the engine on flanges below



Climax Six Cylinder Engine.

the center line—a logical method of mounting a large engine of this type, which will be used chiefly in stationary and semi-stationary service. This type of mounting also makes it possible to use large hand holes in the upper half of the crankcase, which makes the interior very accessible. The arrangement of the accessory drives is such that they do not interefere with this accessibility.

Timing gears are mounted next to the flywheel to secure quiet running and lasting service. In this location, they are not lashed by the torsional vibration and whip of the crankshaft. No idler gear is used in the timing gear train, which, of course, simplifies the construction.

Flywheel housing is detachable and forms, also, a cover for the timing gears. This construction permits of changes to meet special requirements.

The oil pump is bolted to the crankcase near the center and is a complete unit. It is driven by means of a shaft through spiral gears off the camshaft, the driving shaft being also a complete removable unit.

The oil pump discharges through a drilled hole in the crankcase to a steel manifold, which is bolted on the outside of the crankcase and which distributes oil through four drilled holes to each of the main and camshaft bearings. At the rear end of the manifold is the relief valve for controlling the pressure, the overflow from which passes through the crankcase and spills over onto the timing gears. The removable steel oil manifold makes a simple and reliable construction, requires fewer long drilled holes in the crankcase and makes the entire system easily cleaned.

The cylinder barrels are in the form of renewable sleeves of the semi-floating type. By this construction, a cylinder wall of proper and uniform hardness can be obtained and the wall thickness can be maintained uniformly, and thin enough to secure the desired cooling. The cooling water comes into direct contact with the cylinder sleeves. With the semi-floating feature, the cylinder barrel does not tend to go out of round under the influence of temperature changes.

In an effort to keep the sides of the engine clear for accessibility through the hand holes, all of the accessories are placed at the ends of the engine and no lay shaft is used.

The water pump is driven by means of a cross-shaft through helical gears at the front end of camshaft. The pump, including the shaft and bearing, is a complete assembly which may be removed as a unit. The governor assembly, including the spring and control linkage is also a complete unit.

The magneto bracket assembly is compact and can easily be removed as a unit. The assembly includes magneto, battery distributor, drive shaft and bearings, drive gear, governor flyballs, and the linkage for synchronizing the magneto and battery spark.

The ignition is an independent dual system, battery and magneto. The timing of the two distributors is synchronized by special linkage so that the engine may be operated with two sparks, which is a decided advantage in heavy duty engines. There are two spark plugs per cylinder.

This engine is made by the Climax Engineering Company, 2 West 18th Ave., Clinton, Iowa.

Traction Wheel Mountings for Railroad Type Steam Shovels

The Osgood Co., Marion, O. has recently built, and successful tests have been made of traction wheel mountings for one of the heaviest railroad type steam shovels. The shovel, an Osgood 120, 6 cu. yd. has heretofore been mounted only upon standard railroad trucks. On account of the time necessary in laying track for moving the shovel, railroad truck mountings were slow in getting from one point to another. This size shovel is much used in big rock quarries and open mines and usually when blasting operations were in progress it was necessary to lay track and move the shovel back from the face of the excavation and then up again after the explosives had been set off. These operations were not only costly in time and labor consumed in making the changes, but also in decreased output through time lost.

Giant traction wheels were designed that measure 6 ft. in diameter and have a face of 36 in. on the front or drive wheels and 30 ins. on the rear wheels. The front wheels are used as drivers and power is delivered through a series of gears from the powerful hoisting engines on the shovel. Steering is accomplished by turning the rear wheels by means of a screw shaft and traveling nut. The nut, to which is attached the axle tongue, moves along the screw shaft, slewing the rear axle and wheels in the direction desired. The screw shaft is operated by a separate reversible steering engine mounted above deck alongside the boiler, out of the way yet readily accessible. Reversing the engine causes traveling nut to move in opposite direction. The engine is controlled and steering accomplished by means of a single lever from the engineer's position in the forward end of the cab.

In recent tests made in a large Pennsylvania stone quarry the shovel was moved a distance in one day that under old track laying methods would have required at least ten days.

The advantages claimed for traction wheels over railroad trucks for large railroad type steam shovels briefly summarized are: greater mobility of machine, elimination of pit crew, easier accessibility to face of excavation, elimination of tracks and reduction of side strains and racking to the machine in general. Traction wheels also have a decided advantage over any other type of mounting in that the traction wheels are much less complicated, simpler to operate and have a much lower upkeep cost.

Some idea of the size of the shovel can be gathered from a few figures. The shovel has an over all length of slightly more than 85 ft. and the over all width is 20 ft. with a maximum height over the cab of 15 ft. while the boom extends to a height of 32 ft.

6 Cu. Yd. Shovel on Traction Wheels in Operation in Pennsylvania Quarry.

Mounted 24-Inch Symons Disc Crusher

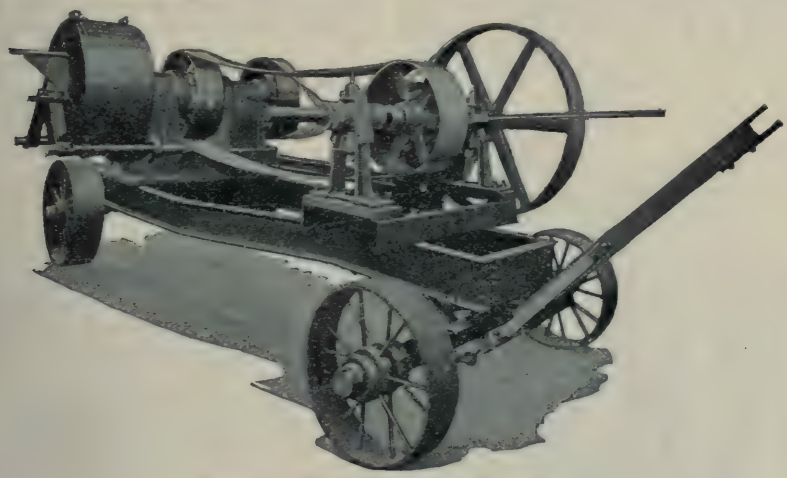
The machine here illustrated was designed to meet the demand for a portable crusher that would produce a well graded product for repairing macadamized roads. There are many sections of the country where roads have been completed and now require top dressing to keep them in condition, for which service there is use for a crusher that can be easily transported from place to place and that will re-crush either gravel or stone up to about 2½ in. diameter and turn out a well graded product ½ in. to ¾ in. with a certain percentage of fine crushed rock and a small percentage of dust.

The Symons Disc Crusher has proved to be an efficient machine for this work. It is mounted on a substantially built steel truck on which are also mounted countershaft, bearings and pulleys.

It has been found in practice, that when the crusher is adjusted so that all of the product would be reduced to pass a slot ½ in. in width, the capacity ranges from 10 to 15 tons per hour, depending upon the character of material being crushed and the method of feeding. Fifteen tons can readily be secured, crushing gravel or limestone, provided the feed does not contain any pieces over 2½ in. diameter.

A 25 hp. motor is ample for driving the crusher and countershaft, the actual power requirements being 18 to 20 hp., when under full load. The crushing faces are manganese steel, and as they wear uniformly the same character of product is produced throughout the life of the crushing members.

This crusher is made by Chalmers & Williams, Incorporated, Chicago Heights, Ill.



Chalmers & Williams Portable Disc Crusher.

A New House Insulating Material

House insulation against heat, cold and sound is a form of building economy that is becoming more and more popular. One of the latest developments in insulating material is that of the Wood Conversion Co., Cloquet, Minn. For some years this company has been making an investigation with a view to determining some way of improving the well recognized heat insulating properties of natural wood. It was reasoned that if wood could be made lighter in weight and more porous, so as to have a greater volume of still air spaces, its natural heat resistance would be increased. It was along this line that research was directed, with the result that a method was discovered whereby a product could be made from wood that weighed only one-fifth as much as the original wood and has numerably more still air spaces. The woods used primarily were white pine, spruce and

balsam. The natural weight of these woods when thoroughly dry is about 20 to 25 lbs. per cu. ft. The new heat insulating product made from them weighs only 4 lbs. per cu. ft. The process by which the natural wood is converted into this new form of heat insulation consists in first cutting the wood into chips. The chips are then placed in digesters and cooked under pressure until they are reduced to a pulp. The pulp is then combed out so that the fibres are separted one from another and in this condition are chemically treated to render them water or fireproof. The

Installing Balsam-Wool Insulation

pulp is then dried and passed through shredding engines, which pick the fibres apart and blow them through distributing hoods against a moving screen. This screen permits the air to pass through it but catches the fibres, which deposit themselves upon the screen in the form of a blanket 1 in. or more in thickness. By this method of deposition the fibres arrange themselves in all three cubical dimensions and not in one plane, as in the art of paper making. It is because of this peculiar arrangement of the fibres that the resulting product is so light in weight and possesses such a large number of still air spaces. As the fibres are depositing themselves upon the moving screen they pass through an atmosphere of adhesive. This causes the fibres to be tacky or sticky when they strike the screen. The screen then moves through a dryer, where the moisture in the adhesive and fibres is removed and in this form the fibres are cemented together into a porous sheet or blanket. This blanket is then passed between two moving sheets of waterproofed kraft paper and is cemented to the sheets by a thin film of high melt point asphalt. The continuous ribbon thus formed is then slit to the desired width and automatically cut off to the desired length and rolled into bundles. The bundles ordinarily produced for house insulation are of two widths—16½ in. and 32 in.—containing respectively 125 and 250 sq. ft. to the roll. The weight of the finished product, including the package, is under 250 lbs. per sq. ft., ½ in. in thickness. A plant has been constructed at Cloquet, Minn., for manufacturing this new house insulation and the product has been given the trade name of "Balsam-Wool."

Portable Bin With Screen

The bin illustrated herewith in its lowered position for moving is made by the United Iron Works of Kansas City, Mo. When the bin is raised the discharge spouts are at the proper height for discharging into wagons. Braced steel frames for supporting

"United" Portable Bin Ready to Move.

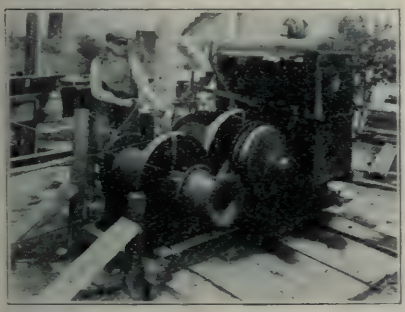
the bin in its raised position are folded up and out of sight in the view here shown. Lifting and lowering are accomplished in a few minutes time by blocks and tackles which are shown in the picture.

Improved Hoisting Outfit

To add to the usefulness of heavy duty hoisting outfits for contractors' or constructors' use, the Novo Engine Company, Lansing, Michigan, has perfected an independent clutch sheave which is applied to their reversible heavy duty type DH hoists.

The independent sheave is controlled from the operating side of the hoist, the operating lever being clearly shown in the photograph below. The sheave is mounted on the rear drum shaft and is driven by a positive friction clutch. The clutch is of the expanding ring type, turned to size and peened to provide contraction when released.

Reversing the direction of rotation



Novo Hoisting Outfit With Independent Clutch Sheave.

of the independent sheave is accomplished by a shifting lever above and slightly back of the clutch sheave shifter lever. It is unnecessary to disengage the sheave clutch to reverse the direction of rotation of the sheave, as the intermediate shaft reverse clutch will perform this function by simply moving the shifter lever toward or from the operator, as the case may be.

A powerful brake, of the contracting type controls the load, the same foot pedal operating the rear drum brake and the clutch sheave brake. A ratchet locks the clutch sheave brake in any position and is released by a hand lever on the operator's side of the hoist.

"V" shaped hard maple friction rings eliminate any possibility of oil getting in the friction drive mechanism of the drums proper. This feature is especially noteworthy, as the "V" shaped blocks furnish double the friction surface obtainable with the ordinary type of drum friction drive. The drums are also controlled by contracting brakes, foot operated.

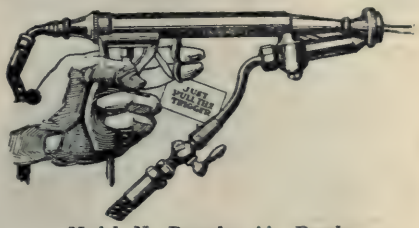
Another improvement is in the "screw thrust" mechanism operating the drum frictions. A high carbon steel thrust screw, hardened on the thrust end, operates against a hard bronze washer, which is interposed between the thrust screw and drum shifting collar mechanism, all of which runs in a bath of heavy oil. The oil is distributed over the parts by means of dippers or arms on the collar which is screwed and pinned on the end of the drum shaft. This arrangement provides a very sensitive control, with the wear reduced to one part, the hard bronze washer, which is easily replaceable.

The photograph depicts the operator using both drums and the independent clutch sheave. His left hand is regulating the throttle of the 40 hp. Novo engine, his right hand the front drum shifter lever. The operator is using but his thumb and forefinger to operate the drum shifter lever.

The front drum of the hoist in this picture is being used to raise a concrete bucket, the rear drum to hoist lumber, while the independent sheave is being used as a dragline to keep the materials close to a concrete mixer. The contractor and owner of the hoist is the Anton Kettler Construction Co., Omaha, Nebr.

Improvements in Guns for Air Brush Painting

The air brush illustrated below has air and material outlets entirely separate. Air only enters the air chamber—the paint, varnish or other



Model N, Paasche Air Brush.

material is supplied through another outlet and release of trigger automatically seals both outlets against dripping and gumming with consequent elimination of clogging. This tool is manufactured by the Paasche Air Brush Co., 1909-23 Diversey Parkway, Chicago.

New 1¼ Yd. Heavy Duty Steam Shovel

The Osgood Co., Marion, O., has added another unit to its line of revolving steam shovels in the new 1¼-yd. heavy duty which is now ready for the market. The 1¼-yd. heavy duty is of the full revolving type and has incorporated in its construction the standard Osgood features of proven merit, such as horizontal hoisting engines; submerged tube type vertical

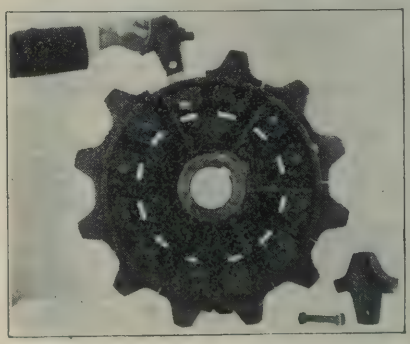
Osgood 1¼ Yd. Heavy Duty Steam Shovel

boiler; centering gudgeon for connecting main body casting to path gear; simplified continuous tread mounting; power steering on both continuous tread and traction mounting; double geared shipper shaft; automatic trip rope tension, etc. The hoisting, swinging and crowding engines are of ample size and stroke to furnish a surplus of power for all ordinary uses. The entire machine is designed for heavy work with oversized shaftings and large bearing surfaces at points of great stress. The hoisting and swinging units are assembled above deck on the upper body center member, a one-piece open hearth steel casting. The truck frame is a one-piece open hearth steel casting completely machined to take either continuous tread, traction or railroad trucks, all of which are readily interchanged. The machine can be equipped with high-lift boom or trenching dipper, and is stated to be especially adapted for use with clamshell or dragline bucket or as a crane. The drums furnished for clamshell or dragline equipment are of sufficient power to operate the buckets with single lines. In general design the machine is modeled after the Osgood ¾-yd. heavy duty machine.

Removable Teeth for Caterpillar Wheel Save Time of Sprocket Changing

The picture below shows a trench machine caterpillar sprocket wheel made with removeable teeth, so that when it becomes worn the teeth may be replaced without the necessity of jacking up the machine and removing the caterpillar units in order to remove the worn sprockets from the shafts and replace them with new ones. The center of the new wheel is not subject to wear, and therefore remains in place when once installed. The teeth are easily changeable while all other parts in the caterpillar remain in place.

A second feature of the wheel is the provision of sets of teeth in two sizes—the first a small size for use when the chain is new, and the second a larger set to provide for the elongation of the chain through wear. One of the larger teeth is shown in the



New Caterpillar Sprocket Wheel.

lower right hand corner of the picture, and shows clearly the extra thickness of the rim section which affects the circumferential pitch and takes up the looseness of the worn chain. This greatly increases the useful life of the chain.

The new wheel is made by the Inland Engineering Co., 6 North Michigan Ave., Chicago. Mr. R. C. Rorabeck, Consulting Engineer was the designer.

Improved Haiss Loader

The creeper path-digging loader here illustrated presents several recent improvements over its predecessors. It is now equipped with a 37 hp. gasoline engine, enclosed transmission box, clutches running in oil, and the transmission is equipped with a differential as heavy as that used in

Haiss Creeper Path Digging Loader.

a 5-ton motor truck. The creeper links have been materially improved, having been made heavier and are so designed that the wedged tooth sprocket which drives the link pushes any dirt that may get into it out on either side. The creeper links are overlapping and are of 35 carbon steel electric made by the Sivyer Steel Casting Co. of Milwaukee.

The mechanism of the Haiss patented slow speed crowding device has been improved, and this device crowds the Loader into the material at a speed of 24 in. a minute. The elevator is now equipped with a raising and lowering device consisting of sheer legs actuated through a gear and worm operated by the operator. One man can raise and lower the elevator, and this device is especially valuable when working on uneven ground where it is desired to raise or lower the elevator an inch or two.

An improvement on the Loader consists of long side guards nearly the entire length of the elevator which prevents any material that may spill from the buckets from dropping on the operator.

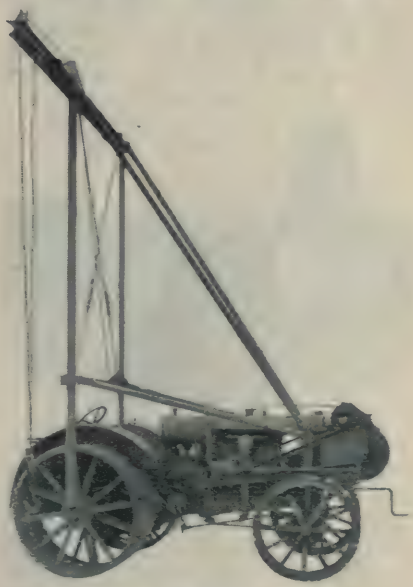
While the machine has a rated capacity of 1½ yds. per minute, tests made by the City of New York with their machine show that it has loaded as high as 3 yds. in 55 seconds.

The engine is a Waukesha type developing 37 hp. at 1000 r.p.m. It is equipped with an air cleaner, magnetor, inbuilt governor, and very simple controls. The machine is operated by one man who stands on the platform built on the left side of the machine. The propelling speed is 100 ft. forward, 60 ft. reverse and 24 in. a minute into the pile.

This machine is made by the George Haiss Manufacturing Co., Inc., of New York City.

New Tractor Hoist

A new tractor hoist designed for use in the oil fields and for all kinds of industrial hoisting work within its capacity, has been brought out by the Twin City Co., Minneapolis, Minn. For oil field work, its principal use is for pulling pump rods, tubes, and casings and for driving the bull gear



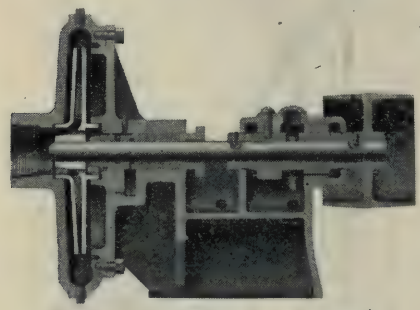
Twin City Tractor Hoist.

in the derrick off a sprocket provided on the hoist drum shaft. It is equipped with the positive reverse and the drum is so designed that it will be allowed to spin free when lowering operations are in progress. For industrial work, the tractor hoist may

be used for such work as pile driving, hoisting material on construction work, land clearing and stump pulling, and it may be used on any kind of hoisting commonly done with steam. A simple pipe frame work can be furnished for handling sections of industrial railroad tracks used in building concrete highways. Assembled sections of industrial track, 30 ft. long, can be handled by three men and the tractor hoist can be used for moving loaded cars forward over freshly laid track as the work progresses. The tractor hoist has a pull of 5000 lb. at 160 ft. per minute on a single line and a lowering speed of 232 ft. per minute. It is equipped with double brakes capable of holding a full load with ease.

Details of De Laval Centrifugal Pump

The section below shows the small, single stage centrifugal pump made in 1 in. and 2 in. sizes by De Laval Steam Turbine Co. of Trenton, N. J. In this design very little wear comes on the main parts of the pump, practically all wear being taken by small and easily replaceable parts. The large bearings, heavy shaft, guide bearings, and the arrangement of the packing gland all insure long life, and at the same time, if the parts do become worn they can be easily and quickly replaced. Each part is manufactured to limit gages and after manufacture it is again gaged before going to the store room. No hand fitting of any kind is permitted during the assembly of the pump, thus insuring that all parts will be perfectly interchangeable, and eliminating the annoyance and expense of fitting repair parts.



Sectional View of De Laval Pump.

The impeller, which is of the enclosed type, is designed to give high efficiency, and is accurately balanced dynamically and hydraulically. The leakage joint, where the impeller runs close to the casing, is in the form of a wide sealing ring, to reduce leakage and insure long life. The large clearance between impeller and casing renders unnecessary accurate adjustment of the position of the shaft. The shaft is of large size, providing rigidity to resist vibration and large area for the bearings. A machined thrust collar is attached to the shaft to maintain endwise adjustment and also acts as an oil slinger to prevent loss of oil from the bearing. The oil well is of large size to permit settling of dirt from the oil. There is an opening for cleaning, and a convenient oil indicator for determining the height of the oil. A cast iron cover permits inspection of the bearing and oil ring. Adjacent to the impeller is a guide bushing made of bronze. The bore is reamed and the outside is ground to gage. This bushing is lubricated by the water, but is also equipped for grease lubrication where desired. It adds greatly to the life of the running parts as it avoids overhang and vibration of the shaft and wear of packings and destruction of the main bearing. The stuffing box, which is separate from the guide bushing, is extra deep and allows the packing to be run loose, insuring long life to both packing and shaft. It is relieved of all strain by the guide bushing.

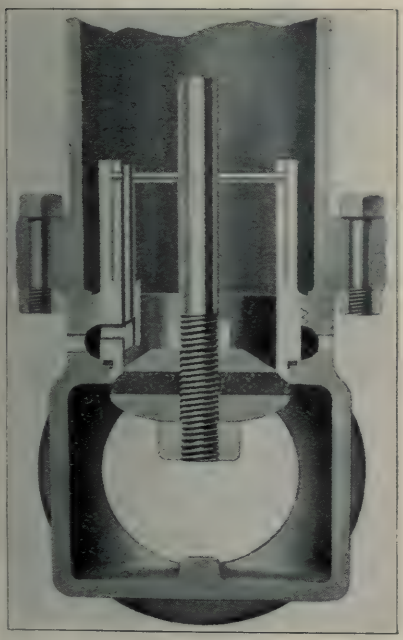
New Atlas Gelatin

The improved gelatin recently placed on the market by the Atlas Powder Co. is reported as giving excellent results. One foreman advises that his men have reduced the number of sticks to the hole and have stopped three fans as gas is no longer troublesome. A resident engineer on a large tunnel reports that his men could return to work in 12 to 18 minutes, which with old-style gelatin it required at least 30 minutes before the men could return, and then they could not stay. In addition to these advantages, the manufacturer advises that the new explosive is extremely high in water resistance and also practically perfect in plasticity.

Non-Jacketed Fire Hydrant

The Waterous Fire Engine Co. of St. Paul, Minn. has recently brought out a non-jacketed fire hydrant, a sectional view of the base of which is given herewith. The new hydrant is of the compression type, and is thoroughly non-freezing in spite of its jacketless design.

The hydrant spindle nut mechanism is not exposed to water, thus eliminating possibility of freezing during the winter. The packing gland is below, thus eliminating water and moisture. This also permits lubricating; insuring an easy operating hydrant. Should threads become stripped, due to abuse or ignorance, the hydrant will automatically shut itself off. It is also possible to open valve even with thread stripped.



Details of Drain of New Waterous Hydrant.

The number of moving parts is small, and there are no toggle motion, cotter pins or wedging actions.

The drain consists of a cylindrical plunger which moves in exact synchronism with the hydrant valve spindle. This plunger performs its functions as follows: When the hydrant is opened the drain plunger moves downward with the valve spindle and overrides the circular drain opening, absolutely sealing and preventing water from escaping at this location. Likewise, when the hydrant is closed the plunger moves upward and at the instant the valve closes the plunger uncovers the circular drain opening, permitting the hydrant to quickly free itself from water.

Motor Pick-Up Street Sweeper

The illustration below shows the latest development in street cleaning equipment made by the Foamite-Childs Corporation, of Utica, New York. The exclusive features most emphasized by the manufacturers are the automatic gutter broom which sweeps clean to the curb, and the convenience of control of all main parts from the driver's seat. Other specified advantages are as follows:

Large rear broom so designed that wear automatically shortens distance between broom and conveyor.

Broom stops when shear pins break, making it impossible to foul the conveyor.

A non-clogging type of conveyor of larger carrying capacity. No choking on heavy sweepings.

Foamite-Childs Motor Pick-Up Sweeper.

Conveyor has a removable bottom, easily replaced.

A straight-side hopper, without shelves or bridges to hold back the sweepings when dump is operated.

Only six drive chains on the entire machine, including the conveyor. Half the usual number of chains.

All mechanical parts are more accessible.

Sweeper will operate while machine stands still.

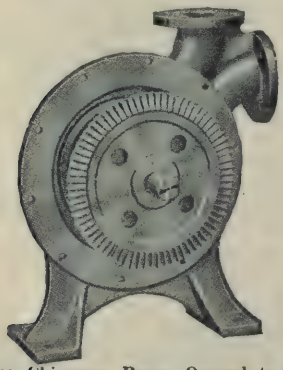
Working speed, nine (9) miles per hour.

Improved water sprinkling system.

The Westco-Chippewa Rotary Pump

The character and arrangement of parts of the rotary pump made by the Westco-Chippewa Pump Co. (formerly the Western Pump Co.) of Davenport, Iowa, are well illustrated in the cut herewith.

This pump has but one moving part —a circular disc, or wheel, called the impeller. It is fastened to the shaft and has a certain determined number of blades on each side of the outer rim. The impeller, rotating at high velocity in the water channel, causes the water to be drawn by powerful



Westco Chippewa Pump Opened to Show Impeller.

suction from the source of supply and discharged under pressure at the outlet.

As the water is taken in at the periphery and discharged at the periphery, it is apparent that the Westco pump is entirely different from the centrifugal type, which takes the water in at the center and discharges it by centrifugal force to the outlet at its circumference.

Most Westco pumps are directly connected by means of a flexible coupling from shaft to electric motor. The shaft revolves in two bearings. The only parts subject to wear are these bearings, which will give years of service, but are so constructed that they can be easily replaced, if necessary.

The majority of Westco pumps are made for standard 1800 r.p.m. electric motors, which generally operate under a full load speed of 1750 r.p.m. However, they are also made for belt connections to gas engines, electric motors, and line shafts.

Bucyrus Improves Heavy Duty Shovel

The 320-B revolving shovel replacing the 225-B shovel has recently been brought out by The Bucyrus Company of South Milwaukee, Wisconsin.

The 320-B in general is a heavier and more powerful shovel than the 225-B. It retains features characteristic of its predecessor, chief among which may be mentioned the following:

The deep box girder type revolving frame, which provides the most rigid possible support for the machinery, with the least possible number of connections and rivets.

Short rear end radius which permits the shovel to work in deeper cuts and to be placed closer to the bank.

The characteristic box girder type boom with outside dipper sticks, which is a Bucyrus patent. This type of boom is designed to withstand the heavy bending and twisting strains of digging, while affording minimum weight for a given strength. The one part hoist, besides being an efficient means of transmitting power from the engines to the dipper, makes the shovel very fast in action. It is never forced in maintaining a working speed of a cycle in 45 seconds and has a surplus power to be speeded up if an occasional demand arises.

The boom has been made extra long between the shipper shaft and the sheave at the point of the boom. This not only increases the leverage of the hoist rope, resulting in greater digging power, but greatly reduces the work for the boom engines, lessens the power thrust in the dipper sticks and the heavy ware on the racks and pinions.

Another feature is the large scale chamber boiler set crosswise. The scale chamber feature permits mud and sediment to collect in this chamber instead of on the crown sheet and in the water legs. The method of setting the boiler crosswise makes it more convenient for the fireman, and means also a less exposed crown sheet when digging or moving on a grade.

The mechanical equalizer is absolutely fool-proof and reliable.

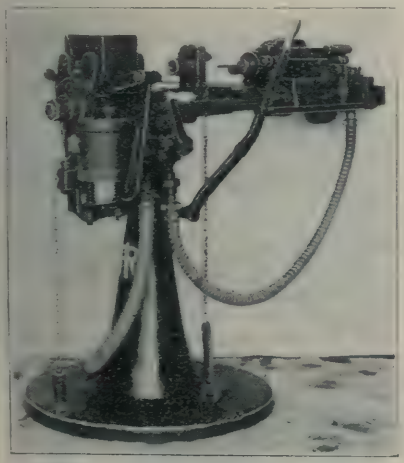
The trucks are placed directly under the corners of the base, 30 feet apart each way. They are of the three-point type, extremely flexible and distribute the loads evenly over

all four wheels. With this type of truck it is possible to use 100 lb. rails.

This new machine weighs 625,000 lbs. in shipping condition, and with an 85 foot bottom, may be equipped with a 58 foot dipper handle and a 6 cubic yard dipper, holding 7½ cubic yards when heaped, or a 54 foot handle with a 7½ cubic yard dipper, which can hold 8⅛ cubic yards of material. It may be had as a dragline excavator and may be operated either by steam or electricity.

New Shank and Bit Punch

To meet the demand for a device to punch holes when shanking and bitting hollow drill steel, the Ingersoll-Rand Company, 11 Broadway, New York, now has on the market a new type of machine for this purpose, known as the "IRLP" Shank and Bit Punch.



"IRLP" Shank and Bit Punch.

Realizing that some would desire a punch as part of their sharpener, while others would prefer to have the punching machine as a separate independent unit, the manufacturer has produced this new type of punch in two patterns.

(1) The attached to sharpener pattern which can be attached to any of their No. 4, 5 and 50 Sharpener.

(2) The pedestal pattern, which is an independent, self-contained machine with pneumatic clamp, mounted on its own substantial cast iron pedestal base.

Special features which the manufacturer claims for this punch are:

(1) Simplicity of design and operation.
(2) Automatic centering.
(3) Clamping capacity.
(4) Sturdiness.
(5) Compactness.

The punch is very compact. The attached-to-sharpener pattern weighs but 227 lbs. No extra floor space is needed for this type. The pedestal type weighs 610 lbs and requires a floor space of 2 ft. 6 in. by 4 ft. 6 in.

The entire punch is under single lever control. By holding this hand lever forward, compressed air is admitted to a hammer cylinder and by a series of rapid hammer blows, the hammer cylinder with punching pin attached is moved forward, thus punching a hole in the drill steel shank or bit which is held firmly in position by the clamping device.

To remove the pin from the drill steel it is only necessary to release the hand lever. Springs attached to this lever return it to its normal position, whereby air is admitted to the opposite end of the hammer cylinder and the pin is withdrawn by a series of hammer blows. It will be seen that this hammering action will have a good effect on the drill steel for mechanical hammering or working of the steel will increase the strength.

The centering device assures holes which are centrally located and, according to the manufacturer, will eliminate the chief cause for breaking water tubes. This device is automatic in action and will accommodate any shape of steel ¾ in. to 1¼ in. in diameter.

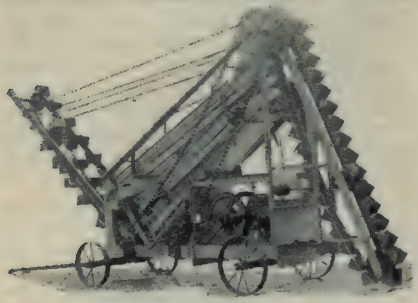
The clamping of the steel for the attached-to-sharpener pattern is done by the sharpener crosshead and with the IR-50 sharpener, the clamping pressure is 14½ tons at the 100 lb. air pressure. In the pedestal type, the clamping jaws are operated thru a toggle arrangement and the clamping pressure is much greater than will ever be required. This assures the steel being held rigidly in position while the hole is being punched.

All parts subject to wear are specially heat treated to give maximum standing up qualities. All parts are manufactured within limit gauges and the machines are constructed on the interchangeability system.

Portable Screening Outfit

The equipment here shown was designed especially for maintenance work by its makers, the Beach Manufacturing Co. of Charlotte, Mich.

It is built entirely of steel, the body of which is only 9 ft. long and 4 ft. wide and when folded down can be run into a common box car. It will



The Beach Screen.

take wet, sticky gravel or material out of the water and screen it and do a satisfactory job. It also works well as a washing plant. The screened material is picked up by an elevator and put either into a truck or bin. The capacity of the machine is from three to four hundred yards per day. It is built light, is on trucks and can be moved readily from point to point.

Rigid Rail Tracks for Fordson

The accompanying cut shows a rigid rail crawler made by The Hadfield-Penfield Steel Co., of Bucyrus, Ohio, attached to a Fordson tractor. This attachment is especially designed for adaptation to the Fordson. The parts are a minimum in number. The track

Fordson Equipped with Hadfield-Penfield Rigid Rail Crawler.

links are manganese steel castings, interlocking when on the ground to form a smooth, rigid track.

The power and abilities of these machines are listed as follows:

They will increase the drawbar pull of the Fordson from 50 to 100 per cent.

They will pull one 8-ft. Road Grader weighing 3,000 lbs.

They will pull one Miami Trailer with a load of 3 tons net.

They will pull two 17½ cu. ft. wheel scrapers in tandem.

They will pull a large size Road or Contractors plow.

They will pull any size Road Rooter.

They will travel about 2½ mi. per hour in second speed when hauling a load and not slip.

They will travel about 1 mi. per hour in low speed when hauling a medium load.

They will plow 1⅛ acres per hour with three 14-in. bottom plows.

They will haul loads of 3 to 5 tons up grades of 15 to 25 per cent.

They will travel over sand or muck where wheels cannot go.

They will turn as short as a regular wheel type tractor.

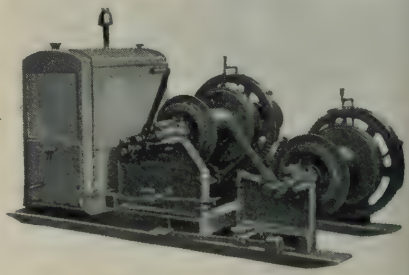
They will operate on the Fordson only.

They will not pack plowed ground like wheel type tractor.

National Junior Hoist

The illustration herewith shows the double drum hoist made by National Hoisting Engine Co. of Harrison, N. J. The name "National Junior" is also applied to the single drum unit. These are small hoists built for all-round service. Four-cylinder Le Roi engines furnish the power.

The ratchet ring is replaceable so that breaks in that quarter cause a



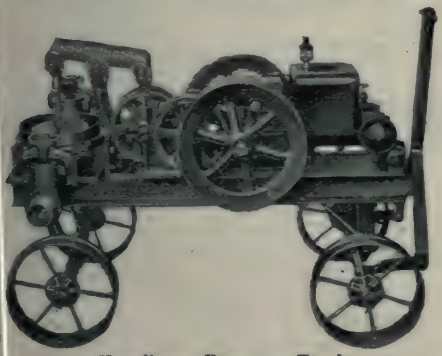
National Junior Hoist.

minimum of inconvenience and expense. Drum bearings are bronze bushed. There is a self-oiling pin and screw thrust. The clutch is of the double-cone friction type. The hoist, as shown, is mounted on skids, but swinging gears can be provided. The single drum unit is designed for the addition of a second drum, easily attached is desired.

Improvements in Humdinger Pump

The Ralph B. Carter Company, 152 Chambers St., New York City, have recently improved their well-known "Humdinger" pump by changes in the valve chamber design, which make the valves interchangeable. These valves are very readily accessible, and ease of clean-out has been made a prime end, thus reducing to a minimum the delays from the inevitable obstructions on many classes of work. The valve chamber cover is held in place by a yoke and hand wheel, by which arrangement it is stated that the chamber can be opened and obstructions removed in about 30 seconds.

This unit was designed to fill the need of a diaphragm pump for a wide range of work under varying conditions. Power transmission is from



Humdinger Pump on Truck.

the engine or motor to an intermediate gear and thence through a double pinion to two large crankshaft gears on the rack proper. This eliminates any side play in the walking beam action.

The closed discharge of the Humdinger makes it especially suitable for manhole pumping without the necessity of temporary trough construction, and adapts it to the pumping of cesspools and all similar work. It also makes the pump a satisfactory unit for deep excavation pumping. It is stated that discharge can be made to heights of about 30 ft.

Improved Garbage Wagon

George H. Holzbog & Bro., Jeffersonville, Ind., makers of sanitary garbage vehicles, have added to their line the steel-bodied wagon here shown, designed especially for the handling of "mixed garbage"—that is both wet and dry garbage in one vehicle. This wagon is built for two horses and has a capacity of about 3 cu. yd. of liquid matter. Of course, where dry rubbish is hauled, this can

Holzbog Steel Garbage Wagon.

be heaped up to the top of the side wings, thereby increasing the capacity. It is built with open top, though if desired to cover the contents the wagon can be equipped with ridge pole and braces so that a canvas cover may be thrown across the top.

Fresno With Improved Details

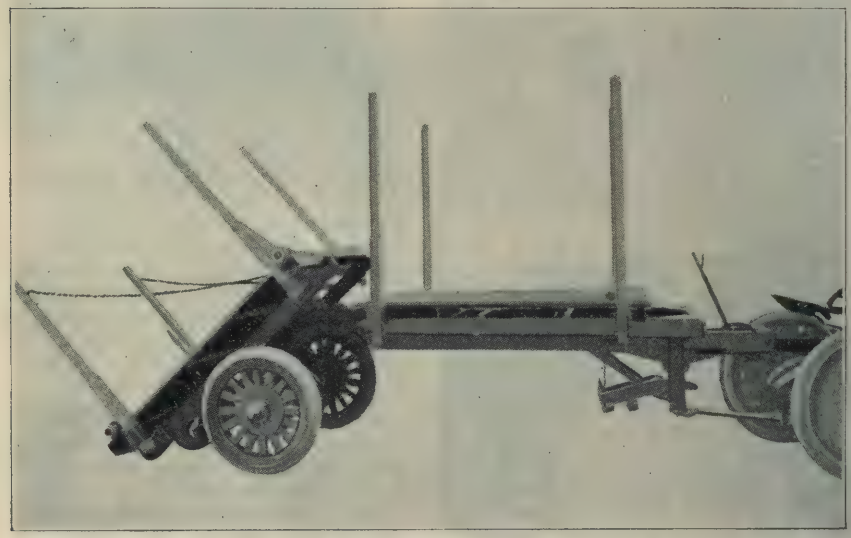
While the Fresno scraper remains an essentially simple machine, improvements in detail are not impossible. The Stockland Road Machinery Co. of Minneapolis, Minn., has added the following features to the Fresno made by it—an angle iron facing to the cross, or leveling bar which protects this bar agains splintering or excessive wear; extra heavy, full

Stockland Fresno With Improvements.

length bowl shoes; handle braces attached through the bowl at a point where the bowl is reinforced by angle irons or runner shoes which is of particular interest to the contractor as it protects the bowl against tearing out of the handle when being used in extremely hard work by two men.

Lumber Dumping Trailmobile

The "Lumber Dumping Trailmobile" here shown is one of seven models, the general features of which were described in Engineering & Contracting for May 30, 1923. This one is Model "Z-5-J," and is of 5 ton capacity. The tongue which rests on the housing of the tractor is carried on spring suspension at the platform of the Trailmobile. This important feature relieves the tractor and load of the road shocks and vibration which result from hauling heavy tonnages. The regular equipment as illustrated includes steel bridge for rear axle of Fordson; draw-bar; steel chassis frame with stout wood floor full length; stake pockets and stakes; hand-operated brake for service or emergency.



Lumber Dumping Trailmobile.

Directions for operating are as follows:

Release the frame lock by moving the handle at the side of the frame; roll the load back by means of the ratchets and the rollers on the rear platform until the weight of the load overbalances the tilting frame. Then the end of the load comes gently down against the ground. Drive slowly forward, and the forward end of the load slides down the incline formed by the tilting frame. This frame comes practically down to ground level so that there is only a few inches' drop to the load, and consequently no damage to the lumber.

By putting a block under the wheel of the Trailmobile and starting the tractor, the frame rights itself and automatically locks. (This can also be accomplished with the brake on the Trailmobile, if care is taken to see that the brake pawl is not engaged.)

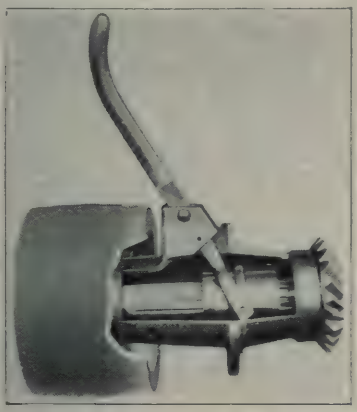
The makers are The Trailmobile Company of Cincinnati, Ohio.

Simple Attachment to Fordson Furnishes Belt Power

A device made by the Dallman Machine Co., 919-935 Winnebago ,St. Milwaukee, Wisconsin, and known as the "Smith Unit" adapts the Fordson tractor to the furnishing of power for general purposes. This unit is bolted in place, and once attached, need not be removed. It is started and stopped by a simple pull of the locking lever, and there is not even a necessary stopping of the engine when a change of use is made from hauling to power supply or vice versa.

The Smith Unit does not change the pulley speed. A pull of the lever slides the sleeve enclosing the idling

pulley shaft, well on to the splined live drive shaft, locking the two firmly for rigid power transmission. When the lever is pushed in the sleeve slides back releasing the idling shaft. In either position the unit is effectually locked by a heavy movable cotter-pin—easily renewed if misplaced. No matter how great the vibration there is absolutely no chance of jarring into or out of mesh. The spiral beveled gear is always in mesh, thereby protecting both the tractor and the unit against damage from possible misengagement.



Sectional View of Smith Unit.

The Smith Unit comes complete with a special laminated composition pulley. The two pulley bearings, one at either end, are interchangeable with the bearings used on the Fordson tractor itself. They run in a constant bath of oil from the crank case.

This Unit makes it very easy for the contractor who owns a Fordson to shift from drawbar or hauling work to belt jobs.

Improved Rex Mixers

Chain Belt Company, Milwaukee, manufacturers of Rex Concrete Mixers and Pavers have recently announced new Rex Mixer Models, Nos. 234 and 237. The new machines are notable for fast charging and discharging. It takes but 8 seconds to discharge the Rex mixing drum on these models, and on the Rex 234 the charging skip can be raised in 5 seconds.

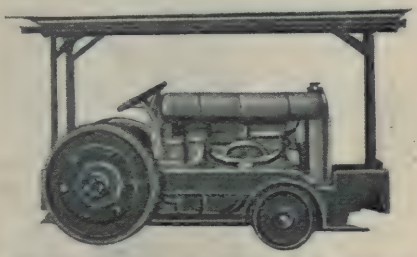
The machines are equipped with several new and distinctive features including a self-contained countershaft supported by self-aligning bearings, a new chain take-up feature, automobile type clutches and a very short wheel base. The entire machine is unsually compact in design, making it an easy machine to handle in close quarters as well as in the open. The design of the blades and buckets has been changed so as to effect faster handling of all consistencies of concrete.

The Rex 237 is equipped with an 8 hp. LeRoi 2-cyl. hopper-cooled engine, while a Novo engine is standard equipment on the 234.

Attachment Converts Fordson to Track Locomotive

The illustration following shows a Fordson tractor converted into a locomotive running on rails by means of a device made by the Adamson Motor Company of Birmingham, Ala. This attachment is built for use in coal mines, ore mines, quarries, brick yards, cement plants, saw mills, sugar plantations and other industries. It is most flexible and economical to operate and is low in first cost.

A Fordson Tractor may be set into the Adamson or changed back into its original form, in three hours, without impairment of the tractor. All parts are built standard, the different gauges being accommodated in the changes of the wheels.



Fordson Converted to Locomotive by Adamson Attachment.

The machine is provided in either of two gears—standard or a special part gear. Handling capacities of the standard gear operating on suitable rail at level grade are—High, 34.7 gross tons; Intermediate, 104.2 gross tons; Low, 158.0 gross tons; Reverse, 86.9 gross tons.

An All-Steel Road Maintenance Scraper

The Root Spring Scraper Co. of Kalamazoo, Mich., is the maker of the road scraper here shown attached to a truck.

The truck equipped with scraper can be backed up by raising the scraper and backing the truck, thereby perfecting any bad pieces of road without having to turn around.

By reason of a long chassis it does away with waves or uneveness of the road, having a planing effect and because of springs the scraper cannot

Root Spring Scraper Attached to Truck.

be fouled or truck stalled, thereby eliminating all danger of damage or crystalization that might occur in a solid or rigid machine.

As a snow remover it works well. With a slow-going machine, windrows of snow are formed on each side of the road. Snow being blown across the road, lodges and fills up the space between the rows, which in time have to be removed by hand. The only way this can be avoided is by a fast-moving machine that deposits the snow on level or far enough away to avoid the above conditions. Six to eight inches of snow can be handled at a speed of 15 to 25 miles per hour.

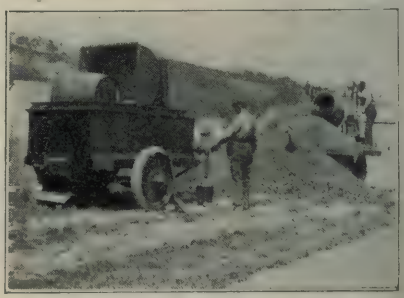
The scraper-blade is 10 ft. long and is made of high carbon spring steel, 8 in. by ¼ in. with extra strip of high carbon steel, oil-tempered, 3 in. by ¼ in. on the lower or cutting edge to prolong the life of the blade, which is practically the only part of the scraper that is subjected to hard wear. This strip is so made that when one edge is worn off, it can be turned over and the other edge used, thus giving you practically two blades in one.

The principle of this scraper, the spring, is not a new one. This same principle replaced the old spike-tooth drag. The springs are 6 in. wide and ¼ in. thick, made to withstand the strain to which they are subjected when the truck is moving at a fast rate of speed.

The scraper, 10 ft. long, is mounted between the wheels of the truck on an angle of 45° across the body of same, and is operated by a windlass double rachet wheel and chain running in a 12 in. shive on scraper shaft. The top of hanger board is mounted to frame or bracket, 21 in. above the ground. The ends of chain are fastened opposite each other on the staff; one holds the scraper up out of commission, the other holds it to its work with any pressure desired.

Tar and Asphalt Heater for Mounting on Trailer Chassis

A tar and asphalt heater designed for mounting on an army trailer chassis has been placed on the market by Littleford Bros., 453 East Pearl St., Cincinnati, O. The kettle of this heater has a capaicty of 300 gal. All seams are electric welded. A 2-in. draw-off valve is provided on each side. The cover is arranged with a



Littleford Trail O Heater in Service at a Central Mixing Plant for Kentucky State Highway Dept.

warming hood under which a barrel of tar or asphalt may be placed for draining. The furnace shell completely surrounds the kettle. It is supported on each side and bolts securely to the chassis frame. A large fire box, with an improved type of fire door and renewable grate bars, is conveniently located at the rear. It is provided with a large ash pit and draft control door.

Oil Burning Tool and Surface Heaters

The Chausse Oil Burner Co., 206 Lincoln Building, Detroit, Mich., is the maker of the machines shown in the two accompanying cuts. They burn either kerosene or distillate, and are therefore without ashes or sparks. They are also practically smokeless and are not affected by wind or rain.

The tool heater can be set going full blast in less than 5 minutes, and will bring 14 or 15 cold tools to proper heat in 15 minutes. Its two tanks hold 36 gallons which is sufficient for 12 hours continuous burning at maximum heat, or a cost of about 27c per hour. As it is frequently unnecessary to use all burners full on, this amount can be appreciably reduced.

The dimensions of Model A-4, with solid rubber tires, Timken bearings and artillery wood wheels (Model A-1 has plain bearings and iron spoke, iron rim wheels) are as follows:

Weight	1200 lbs.
Tread	54 in.
Width over all	62 in.
Length, including tongue	9 ft.
Size of fire chamber	44x36x12 in.
Fuel capacity	36 gallons

The surface heaters are portable, and made in two sizes. Model B-1 has heating chamber 6 ft. square and can resurface 500 to 600 square yards in an 8-hour day, heating to a depth of one inch. Two men and one machine

Tool Heater Model A-4.

will replace four hand-choppers. Model B-4 has surface heating space 3x6 ft. and a capacity of 250 to 300 square yards in 8 hours, to depth of one inch. This depth is reached in four to five minutes. Model B-4 was especially designed for work along street car tracks and it will operate right along the rail head without stopping cars.

Both machines fold up so that they can be readily hauled. They are mounted on springs to minimize road shocks and to prevent jars from loosening pipe connections. The maximum burning period on one filling of tanks with burners on full blast is 8 to 10 hours for Model B-1 which has six burners, and is 20 to 22 hours on Model B-4 which has three burners.

Model B-6 is a rut heater designed to expeditiously repair ruts made by heavy vehicles, cracks and places

Surface Heater Model B-1 Ready to Operate.

where pavements have been opened to reach underground pipes. The pan is 6 ft. long and 9 in. wide and with one man about 72 sq. yds. of pavements can be resurfaced in an 8-hour day, or as much as two or three men usually do in hand chopping ruts.

Data on the surface heaters are as follows:

	Model B-1	Model B-4	Model B-6
Size heating pan	6x6 ft.	3x6 ft.	6 ft.x9 in.
Fuel Capacity	48 gal.	60 gal.	18 gal.
Maximum burning	15 hrs.	25 hrs.	10 hrs.
Weight	1200 lbs.	900 lbs.	300 lbs.
Tread	54½ in.	48 in.	30 in.
Length folded	10 ft.	9 ft.	10 ft.
Length unfolded	15 ft.	....	—
Width unfolded	—	7 ft.	—

Small Reflector for Industrial Lighting

The National X-Ray Reflector Company has developed the reflector here illustrated to meet the needs of a new

New Mill Type X-Ray Reflector.

lamp. It is called the "mill" and is of a sturdy round bulb design to be used where there is a jar or vibration. It completely hides the brilliant filament of the lamp and is designed especially for localized industrial lighting.

Pacific Type Oil Burning Sand Drier

The Pacific Type oil burning sand drier here shown is manufactured by Warren Brothers Company, Boston, Mass., and furnished in connection with new asphalt plant installations as well as for use in connection with existing paving plants.

This drier embodies improvements in sand drying equipment, involving a high degree of efficiency and a minimum of upkeep and operating cost. It is sold under a guaranteed capacity to dry and heat twenty tons per hour of sheet asphalt sand or equivalent.

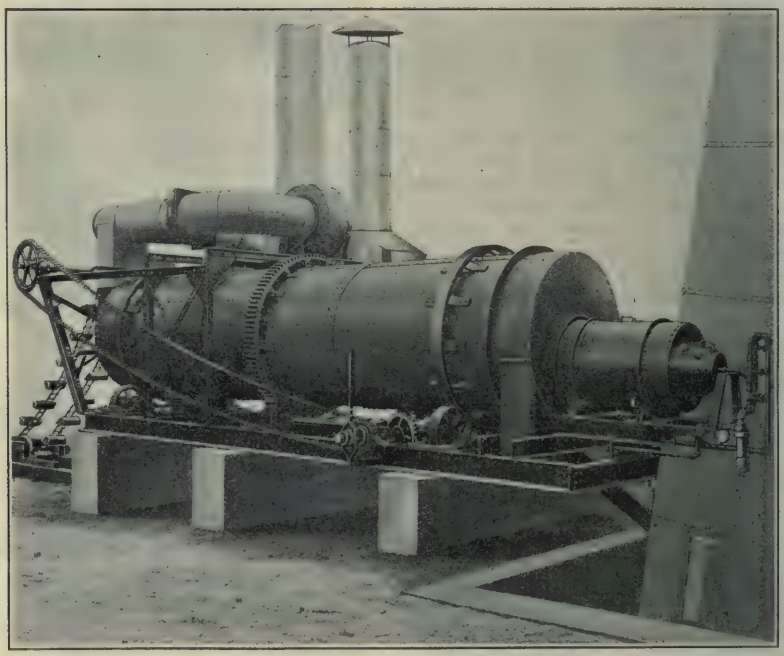
This drier is furnished equipped with driven ring gear, driving pinion and pinion shaft, cold sand elevator, cold sand elevator drive and a fuel oil pumping system consisting of a chain driven rotary fuel oil pump, pressure gauge, relief valve and two fuel oil burners, which burners operate in connection with a cylindrical steel fire brick lined combustion chamber. There are also furnished an exhaust fan and dust piping to connect the fan with the drier.

The entire drier is mounted complete on a substantial steel I-beam frame, the axis of the drier being horizontally parallel with the frame, and the entire outfit placed at the proper pitch to afford the necessary rate of travel of the sand from the cold end to the discharge end.

Heat is furnished by burning ordinary low gravity fuel oil, which is pumped to the burners by the chain driven rotary pump, the oil being vaporized at the burners by live steam from the plant boiler.

The combustion chamber involves a novel arrangement which permits turning it when desired on the grooved trunnion wheels which support it, this arrangement providing for a greatly prolonged term of service of the fire brick lining, as when some particular spot in this lining may have become unduly affected it is only necessary to revolve the chamber slightly in either direction to such a point as will bring the less affected part of the brick lining into service. The combustion chamber is also equipped with a perforated air regulating damper.

Another feature of this drier which adds greatly to its serviceability and long life is its extra heavy weldless



Pacific Type Sand Drier.

locomotive steel tires, these tires being jointless and turned to a true face.

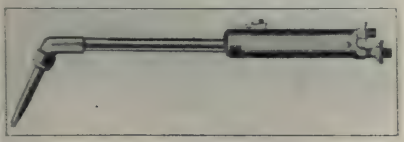
A pronounced innovation in connection with the Pacific Type drier is the provision made for keeping it in its proper position on the trunnion wheels —that is, preventing it sliding forward or backward lengthwise—this arrangement consisting of special bearings at the charging end of the drier. The bearing proper can be slightly rotated horizontally in either direction and held in perfect adjustment by set screws and lock nuts. A tendency for the drum to crawl in either direction is definitely overcome by a very slight swing of the entire bearing, and this arrangement permits the elimination of flanged trunnions and side rollers operating against the sides of the tires.

The Pacific Type Drier permits the elimination of an outer casing; does away with the cost of maintaining brick firebox lining; eliminates expensive grate bar renewals and, owing to the omission of the casing, the life of the drier is greatly prolonged as it is allowed to uniformly cool when shut down, eliminating the unequal stress in alternate heating and cooling.

Combination Cutting and Welding Torch

The Alexander Milburn Co., 1416-1428 West Baltimore St., Baltimore, Md., is maker of the torch illustrated herewith.

To change from cutting to welding or vice versa it is merely necessary to



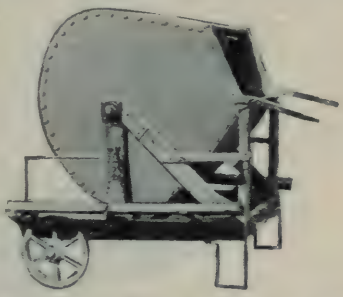
Milburn Combination Torch.

unscrew the tip lock nut and insert the proper tip. It obviates the necessity of using two torches and connecting up new hoses.

The torch is as efficient for either purpose as is a single non-convertible torch. One-half minute is the time required to make the change. One of the distinct advantages of this tool is that a torch for each purpose is on hand on each job and always available for the unexpected requirements that are bound to arise.

A New Type of Hand Power Mixer

The two views herewith show a 6 cu. ft. mixer in the drum of which are two large circular blades with curved vanes on each side. In operation the drum is shaken by hand, and the ingredients are gravitated and thrown back and forth from the blades on op-



Adams Shaker Mixer in Loading Position.

posite sides of the drum passing through two grates located about 5 in. on each side of the axis of the drum. It is claimed that this arrangement greatly reduces the amount of work required for thorough mixing.

The platforms and bumping posts are of wood; all the rest of the machine of steel. The drum revolves or shakes on ball bearings, and is so balanced that two men can operate it at full capacity. The daily output is 20 to 30 cu. yd.

The drum is arranged for discharging directly into forms, thus saving

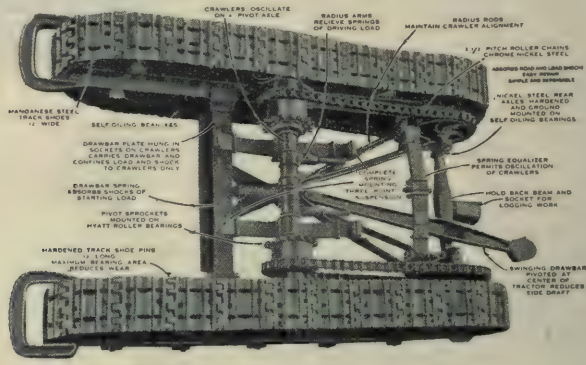
Adams Shaker Mixer Discharging Into Forms.

handling. The mixer complete weighs 400 lbs. and requires less operating space than the ordinary mixing board that it is designed to replace.

The G. W. Adams Shaker Concrete Mixer Co., 158 Rockwood Ct., San Antonio, Texas, is the maker.

The Chain Drive of Monarch Tractors

Herewith is an illustration of the chain drive crawler chassis made by Monarch Tractors, Inc., Watertown, Wis. The form of sprocket tooth used in this drive, which is the standard set by the S. A. E., A. S. M. E., and A. G. M. A. and used by the chain manufacturers in the United States, is a decided improvement over the old style so long in use. The new tooth form produces a softer and quieter action with less tendency to wear the teeth hook-shaped and distributes the load over a larger number of teeth.



6-60 Model Monarch Crawler Chassis.

The life and service of the chain depends to a certain extent upon the speed of the driving sprocket. The chain manufacturers themselves recommend a maximum speed of 325 r.p.m. for 2-in. pitch chain and 200 r.p.m. for 2½-in. pitch chain. In the Monarch installation there is, therefore, a very large factor of safety due to the fact that the speed of the differential shaft, carrying the driving sprocket, at the maximum motor speed of 1,200 r.p.m. runs only 178 r.p.m.

Several well-known automotive engineers have made tests showing that chain drives are 95 per cent to 99½ per cent mechanically efficient.

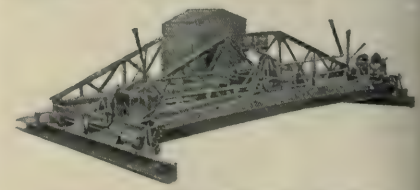
The chain drive, through the direct simplicity of its action, through its elasticity and the efficiency of its rollers, compensates with no loss of power for inaccuracy of teeth in the sprockets, absence of lubrication and misalignment and is easily adapted to the most efficient gear ratio for the speed and load.

In chains the greatest wear is concentrated in a part easily and cheaply removed or repaired. This type of drive being accessible and easy of repair is designed to take most of the driving punishment between the road and transmission. It absorbs all the twists, turns and jerks of bad roads and irregular ground and spends itself to save the more delicate and expensive parts, which are not so easily accessible and quickly repaired.

For this reason wear is likely to appear first in the chains, yet the wear on a properly designed chain and sprocket does not seriously interfere with the mechanical efficiency until a breakage actually occurs.

Improvements in Lakewood Road Finisher

Several important improvements were made in the Lakewood road finisher for 1923. The 1923 model is equipped with an adjustable strikeoff,



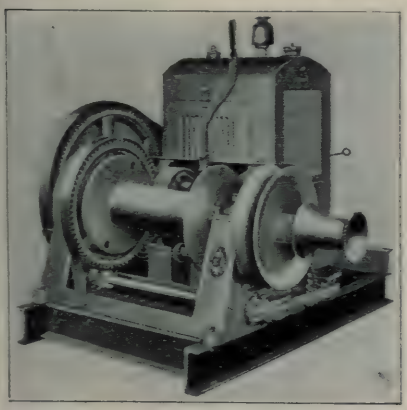
1923 Model Lakewood Road Finisher.

which can be raised or lowered from either side of the road. This will strike off concrete as much as 4 in.

below the top of the side forms, and is particularly useful in placing reinforcement or for two course work. Another improvement is a new style pitman assembly fitted with bronze pitman boxes. The new arrangement gives more efficient action to the strike-off and tamper, and minimizes wear. Transportation wheels are provided so that the machine can be hauled by motor truck or team relatively short distances while assembled. Various mechanical refinements are apparent, such as improved clutches, a drive chain idler which minimizes the effect of slack, improved rail cleaners, etc. This finisher is manufactured by the Lakewood Engineering Co., Cleveland, O.

Reversible Hoist for Builders and Contractors

The O. K. Clutch and Machinery Co. of Columbia, Pa., are makers of the reversible hoist here illustrated for use in building construction, with



O. K. Reversible Hoist.

double cage elevators, logging, car hauling and other hauling or hoisting.

Double platform elevators, as generally used by contractors, are operated by a cable sheave. The cable is given one or two wraps around the sheave, just enough to prevent slippage. When the hoist is run in one direction one elevator goes up, while the other comes down. By reversing the hoist the direction of the platforms are reversed.

A winch head is provided for logging, etc. This is keyed fast to shaft.

It is not necessary to disturb cables either on drum or sheave, as both can be engaged and disengaged independently of each other.

A differential brake, with ratchet and pawl, sufficiently strong to hold any load that may be placed on the hoist is provided.

The two friction clutches are very simple and strong, have no delicate parts to get out of order and only one screw adjustment. They have a very large frictional contact surface and are lined with special asbestos friction lining, which is water and oil proof. Shold they wear to such an extent that new frictions are required, they can be easily renewed—which makes practically a new clutch.

The differential brake is extra large and lined with asbestos brake lining. A ratchet and pawl is also provided on the brake.

"Hercules" High Pressure Pump

The "Hercules" outfit here shown is a product of The Barnes Manufacturing Co. of Mansfield, Ohio. It is a high pressure, outside packed machine with a capacity from 900 to 4,500 gallons per hour depending upon pressure. It is adapted to pressures ranging from 175 to 500 lbs. per sq. in.

There are no cup leathers or brass linings; instead, machined iron plungers are provided. One piece, all bronze wing type valves rest on heavy brass tapered valve seats. Any part of the

Barnes Manufacturing Co. High Pressure Pump on Hand Truck.

pump may be removed for inspection or repair in five minutes. The plungers can be repacked in half an hour or less.

In addition to the horizontal gasoline engine outfit shown, "Hercules" outfits are furnished with oil engines, steam engines or electric motor, either mounted on truck or on steel skids.

The Geophone

While the geophone has come into prominence through its spectacular use in certain recent mine disasters, and while it is also fairly well known as a means of detecting leaks in water pipes, its construction and principles of operation have remained very largely a mystery. The following description, abstracted from an article in the Coal Age, reveals a surprising simplicity:

The geophone is an instrument invented by the French during the war to detect, through the earth, the sapping and underground mining operations of the enemy. It was improved by the United States engineers, and

Set of Geophones in Carrying Case.

more recently has been further improved by the engineers of the U. S. Bureau of Mines, and its use in connection with special sounds has been developed.

The instrument, though small, works on the same principle as the seismograph, the ponderous apparatus by which earthquake tremors are recorded. It consists of an iron ring about 3½ in. in diameter, within the center of which is suspended a lead weight that is fastened by a single bolt passing through two metal disks (pure nickel disks 0.025 in. thick are used), one of which covers the top and the other the bottom of the ring.

There are two brass cap pieces, the top one having an opening in the center to which is fastened a rubber tube leading to a stethoscopic ear-piece. These cap pieces are fastened with bolts to the iron ring and serve also to hold the metal disks in place.

We then have really nothing but a lead weight suspended between two thin disks that extend across a small airtight box. If the instrument is placed on the ground and anyone is pounding or digging in the vicinity, energy is transmitted in wave motion through the earth, and the earth waves shake the geophone case.

The lead weight, on account of its mass and because it is suspended between the disks, remains comparatively motionless. There is thus produced a relative motion between the instrument case and the lead weight. The result is that in the thin space over the disk a compression and rarefication of the air alternately takes place which is magnified at the small outlet.

Since the rubber tube leading to the stethoscopic ear-piece is connected with this space in the geophone, the vibrations are transmitted to the ear drum and, like other rapid air waves, produce sound effects. Usually two instruments are used, one for each ear.

When the observer is so equipped it is found that the sound is apparently louder from the instrument that is nearer the source of sound, even though the geophones are placed not more than 2 ft. apart. It is evident that by moving the instruments a point can be found where the sound will be of the same apparent intensity in both ears. The direction of the point of origin of the sound is then on a perpendicular to the line connecting the centers of the two instruments, either in front of or behind the observer. Further observation will show which side. Direction is quite accurately determined in this way.

The sound is not actually louder in one ear than in the other, but the ear is capable of distinguishing the slight differences in time at which the sounds arrive in the two instruments. Since this is the case persons who are slightly deaf in one ear are able to determine direction with the instruments.

In coal mines it has been determined that the geophone should rest on a solid shelf of coal or on the floor of a niche cut into the coal. The floor of the mine is likely to be covered with dirt, and is seldom solid enough to transmit sound well. In metal mines the geophones will, of course, be held against or placed upon the natural rock.

If the geophones are held with the hands against the coal, vibrations are set up by the circulation of the blood

within the hands, which greatly interfere with successful observations. On the other hand, rock appears to withstand these vibrations, and successful results can be obtained by simply holding the instruments in place upon the rock.

Sledge pounding can be detected in mined-out areas at least 1,500 ft., through solid coal 2,000 ft., and through solid rock about one-half mile. Blows of a pick, tamping bar or heavy rock can be detected at two-thirds of those distances. Talking can be understood fairly well through a 50-ft. coal pillar and can be detected about 150 ft. away.

The geophone is made by the Globe Phone Manufacturing Co., Reading, Mass.

New Capstan Car Puller

A new electric capstan car puller brought out recently by the Gifford-Wood Co., Hudson, N. Y., is illustrated below. In car "spotting" with this capstan it is simply necessary to hook the rope onto the car to be pulled,

G-W Electric Capstan Car Puller.

give it a few turns around the capstan head, and throw the motor switch. No manual effort is required, as the free end of the rope is gently pulled in as it comes off. The capstan occupies a space 2 ft. 8 in. by 2 ft. 9 in. plus room for gear guard and motor housings. It gives a rope speed of 44 ft. per minute, and a pull on rope of 2,630 lb. The capstan has a cast iron housing enclosing the bevel gears and one pair of cut gears. Bearings are babbitted and provided with grease cup lubrication. Bronze thrust collars on vertical shaft. Gear guard and motor housing of No. 14 gauge steel. Shafts of cold rolled steel. Bevel gears of cast iron with cast teeth, 36 and 22 teeth, 1¾ in. pitch. Spur gears of cast iron with cut teeth, 64 and 15 teeth, 4 diametrical pitch; 120 and 15 teeth, 5 diametrical pitch.

Wallis Tractor 15-27

The "New Wallis O. K." tractor made by the J. I. Case Plow Works, Racine, Wis. is pictured below. It is a medium sized tractor rated at 15

Wallis O. K. Tractor Working on Streets in Racine, Wisconsin.

hp. at the draw bar and 27 hp. on the belt but runs substantially above these ratings. The total weight is 3660 lbs. exclusive of water, fuel and oil, which is low enough to give reasonable freedom from bogging in wet ground. All working parts are accessible for inspection and adjustment.

In connection with the use of the machine to furnish belt power the makers list the following points:

One—The "New Wallis OK" can be lined up to any belt driven machinery quickly and easily.

Two—There is absolute clearance. There are no parts to be removed nor are there any to obstruct or injure the belt.

Three—The belt pulley is "lagged" with ¼ inch durable fabric which prevents slippage and consequent waste of fuel.

Four—The proper speed of belt pulley for standard belt speed can be readily and easily maintained.

Five—Improved Construction. The newly designed exclusive Wallis governor, coupled with the use of a tubular radiator and oblong butterfly valve, doubles the governor action and accelerates its "pick-up."

Winch for Clay Tunnel Work

The W. H. Anderson Tool & Supply Co., Dubois and Franklin Streets, Detroit, Mich., is the maker of a small winch especially designed for pulling a clay tunnelling knife, as shown in the sketch here reproduced.

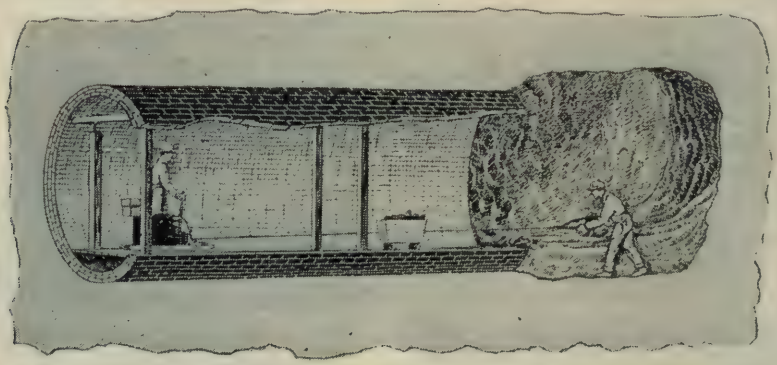
The winch is placed from 15 ft. to 50 ft. back of where excavation is to be made. The knife is attached to the pulling cable. As the winch operator starts the pulling drum the digger holding the knife places it at an angle which causes the cutting blade to cut into the clay to its entire depth. The winch then continues to pull the knife forward at this depth until the end of cut is reached. This leaves a strip of clay approximately half round in cross section and from 8 ft. to 15 ft. in length. These strips are then cut into convenient lengths by muckers and loaders who load the material into mud boxes or cars for removal. At the end of the cut the winch operator releases the friction on the pulling drum, which permits the digger to pull the knife back for the next cut without effort or unnecessary friction.

It is not necessary that the winch shall be placed centrally with the cut for the front end is fitted with rollers, mounted securely to the frame, which guide the cable direct to drum regardless of the angle of cable to knife.

The Anderson tunnelling winch is made extremely compact to permit of its use in small sewers, the extreme width over all being but 26 in. and the extreme length 48 in.

Cut gears are used with special cut fabroid gear on motor to reduce noise to minimum. The machine is fitted with a 7½ h. p. Howell motor, especially built to withstand excessive moisture to which the machines are often subjected.

The manufacturers do not recommend the use of the Anderson winch and knife except on heavy clay digging, but on this class of work they claim greater yardage at less cost than by any of the usual methods employed.



Sketch of Tunnel Work With Anderson Winch.

Flat Type Truck Bodies

The illustrations following show two different bodies recently brought out by the American Production and Trading Co., 4805 South Morgan St., Chicago, Ill.

American Production and Trading Co.'s No. 2050 Truck Body.

The No. 2510 body is built especially for Ford one-ton trucks and is arranged to comply with the best engineering practice in load distribution

on the Ford chassis. The center of gravity of the load is low and is well forward of the rear axle, permitting a capacity load with the least wear and tear on equipment.

This body has special features, such as double-acting tail gate, double spring check chain, double positive locking latches, rolling dogs, and so forth.

This body, as is our policy, gives the buyer the most for his money. With it the contractor is able to obtain the

No. 2510. 1 Yd. Flat Type Body for One Ton Ford Truck

lowest of material handling costs and finds that it serves a wide range of uses.

No. 2050 is made in 2 and 3 yard capacities for all makes of trucks. In its construction all points of strain are heavily reinforced. No. 10 and No. 8 gauge steel is used, all rivets are hot riveted, and all castings are steel castings. It has numerous exclusive features, such as double-locking latches with positive safety device, double-rolling dogs holding the rear end down, double heavy spring check chains and double-acting tail gate with automatic trip and self-locking device on the return.

Quick-Setting Lime Blocks Developed by U. S. Bureau of Standards

A cast lime building tile for use in making partitions has been developed at the Bureau of Standards by the Fellow of the National Lime Association. The material of which it is made sets so that it can be removed from the mold at the end of ten minutes. After twenty minutes it can be handled, and after seven days it has a compressive strength of one hundred pounds per square inch. It can be sawed, and nails can be driven into it.

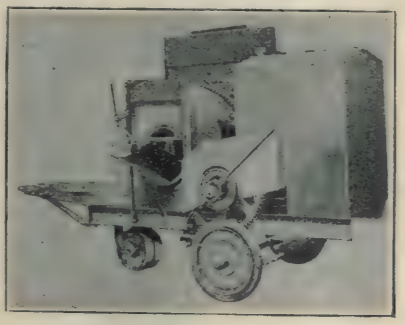
The material is composed of five parts by volume of ground quick lime, ten of hydrate or slaked lime, and one of wood fiber. It is found to cure best when outdoors exposed to the weather. The new tile is about twenty per cent heavier than gypsum tile of the same size, and experiments are being conducted to see if the core volume can be increased without too great a sacrifice of strength.

The quick setting lime of which the tile is made was developed several months ago by the Bureau of Standards, and can also be used for other purposes. Difficulty is found in shipping it, however.

A Mixer That Can Be Towed as Fast as a Truck Can Go

The mixer here illustrated travels on its two rear wheels alone but on the job the double castor wheel in front provides a fully adequate bearing surface on the ground and in addition facilitates moving around. This design of mounting permits of trailing behind a truck with a maximum of ease and convenience, without any sacrifice of stability when in use.

This trailer mounted mixer unit, known as the "Universal" is a product



"Universal" Trailer Mounted Mixer.

of the Marsh-Capron Company of Chicago, Ill.

The steel disk wheels have 3½ in. x 24 in. solid rubber tires, and turn on 5 in. Timken bearings on a 1¾ in. heat-treated automobile axle.

The springs are of the best automobile truck design, silicon manganese steel, 9 leaves ¼ in. thick by 2 in. wide, 32 in. long overall.

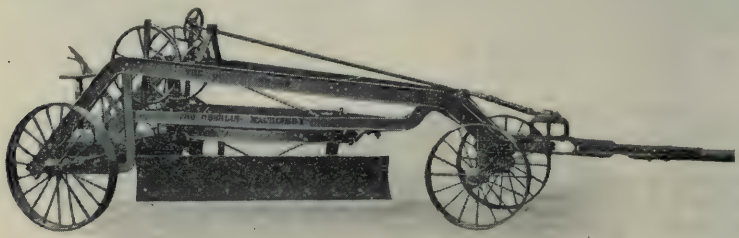
The front castor has two roller type wheels, each 3½ in. face by 15 in. diameter, carried in a heavy cast steel fork, with the pivot pin integral.

A General Utility Grader

The "Ohio Utility," made by The Oberlin Machinery Co. of Oberlin, Ohio, is a heavy grader that can be used in any capacity, being made for severe service and having all the adjustments of the Ohio Standard, and constructed along the same lines.

The frame is made of heavy 5-in. channels and braced so as to insure a rigid construction, for the strains incident to the operation of this grader in hard and stony soils.

The sub-frame and circle to which the blade is attached are constructed of heavy angle and channel and the blade, which is 7 ft. long, is attached to the circle frame with heavy steel castings or forgings.



Ohio Standard Grader.

The Ohio Utility weighs 2,800 lbs. with the tractor or engine hitch, and has a wheelbase of 11 ft. 8 in. The rear wheels are 42 in. in diameter, the rim being 4 in. wide and ½ in. diameter, the rim being 4 in. wide and thick. The front wheels are 30 in. in ⅜ in. thick.

The tractor hitch is made of 2⅜ in. tube with proper fixtures for attachment to the tractor. A pole can be substituted for the tractor hitch so that the grader can be horse drawn. In his change there will be no disturbing of the steering connection, as the steering apparatus is not attached to the tractor hitch.

The rear axle is constructed similarly to the rear axle in the Ohio Standard, with both lateral and swinging adjustments.

Recent Production Records

Julius H. Barnes, president of the Chamber of Commerce of the United States, in an address on Aug. 22 before the National Association of Insurance Agents, at Buffalo, N. Y., cited ten production records that have been established in industry during the last few months. They are:

"The largest pig iron production;

"The largest cotton consumption;

"The largest steel ingot production;

"The largest crude oil production;

"The largest automobile and truck production;

"The largest residential construction;

"The largest production of locomotives;

"The largest volume of mail-order sales;

"The largest volume of retail sales;

"The largest volume of railroad car loadings."

Mr. Barnes also made several significant comparisons of changes that have taken place in the United States since the pre-war year of 1913. The more important of these comparisons are:

"The population of the United States has increased fourteen millions of people, with their enlarged requirements.

"The annual national income has increased from thirty-four billion to fifty billion.

"The aggregate savings deposits have increased from six billion to fourteen billion dollars.

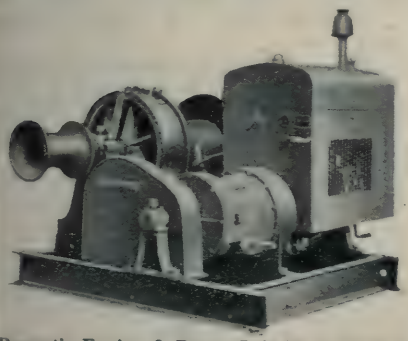
"The deposits in national banks have increased from six billion to seventeen billion dollars."

New Friction Drum Hoist

The Domestic Engine & Pump Co. of Shippensburg, Pa. has recently announced the hoisting unit shown below. As may be seen, the outfit is compact and largely housed.

The unit frame is made of steel channels with steel re-inforcing corner angles, thus insuring rigid foundation and true alignment of engine and hoist.

The thrust apparatus consists of a heavy steel screw and yoke which pushes against the hub of the drum through a thrust bearing consisting of two hardened and ground steel plates with a bronze plate between. The screw also pulls the drum out of engagement by a positive movement. No spring is used to push drum away from friction. This obviates any possibility of friction sticking and gives operator absolute control of load.



Domestic Engine & Pump Co.'s New Hoisting Unit.

The brakes are of band type with toggle to foot levers and top spring adjustment for taking up wear.

The drums are cast iron. They are bushed with anti-friction metal which insures free running.

On these units one winch head is attached to each drum shaft. The winch is large, polished smooth and keyed on the shaft outside the journal boxes.

The engine is a 15 hp., 4 cylinder Le Roi.

All gears are machine cut. The speed reduction gears that run at highest speeds are enclosed in metal housing, are made of special alloy steel, heat treated, and run in oil. The slow speed gears are heavy stub tooth gears and the driving pinion has an outboard bearing.

The engine is controlled by a governor of the flyball throttling type which gives it a very steady running speed. A control lever attached to the governor gives the operator a choice of a wide range of speeds. It is equipped with friction clutch thus permitting starting and running of engine, for inspection or adjustments, free of the hoist and gearing.

A speed control lever within easy reach of operator permits the speed of engine to be minimized when not hoisting and quickly increased when about to hoist.

To the friction there is attached a lever which extends to within easy reach of the hoist operator thus giving him control of the winch as well as hoist drum. This winch control, starting and stopping at will of operator, is often of great value as it prevents accidents when load line over-rides on winch.

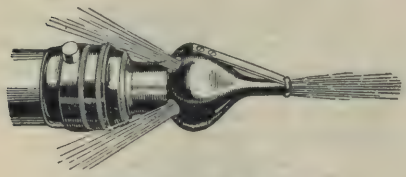
A New Tructractor

A new model tructractor, has been placed on the market by the Clark Tructractor Co., 1130 Days Ave., Buchanan, Mich. Among the important features of this new tructractor are special 2-ton Clark internal gear axle; 27 in. x 10 in. extra heavy steel wheels with reinforced web, wheels are rim cast integral or 28 in. x 7 in. wheels if Giant rubber tires are used on the driving wheels; an improved air cleaner which keeps dust from the carburetor feed. The tructractor is of all steel construction; hot riveted steel channel chassis frame; electric furnace steel castings used for spring hangers, differential housing, rear cross member and all other units subject to stress and strain. It will carry 22 cu. ft. of wet concrete, 30 cu. ft. of dry aggregate. It has a speed of 10 miles per hour, and can climb a 15 per cent grade under full load.

Special Contractors Model Tructractor.

Self-Propelling Tool for Cutting Roots in Sewers

Three years ago an ingenious tool was placed on the market for removing obstructions in clogged sewers, pipes, drains and culverts. This device was operated primarily as a water propelled tractor. It contained a relatively circular chamber with a small forward opening, and a number of large rearward openings surrounded the intake. The tool was attached to hose, which in turn was



Self-Propelling Root Cutter.

attached to a fire hydrant. Upon water being introduced through the hose, to the tool, the force of the water striking on the relatively circular forward structure of the tool, and then rebounding and escaping through the rearward holes produced a recoil which drove the tool forward in the opening at the rate of several feet a minute. Shortly after its introduction, diagonal vanes were placed in the intake and the body of the tool was connected with a threaded connection by a thrust-bearing which caused the tool to revolve. This feature materially increased its efficiency.

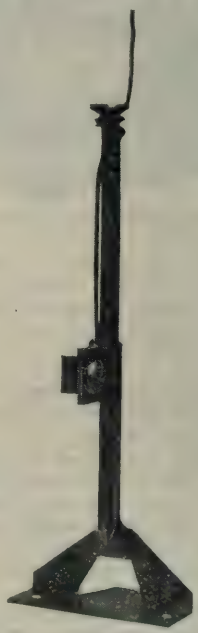
During the past three years the engineers who were responsible for the tool have been trying to add one more essential feature, to enable it to chop the roots of trees which grow into sewers and form a large mass therein; also chop small sticks which become lodged in sewers and cause other material to back it and blockade the sewer. The result of their work is the self propelling root cutter, which operates on exactly the same principle as the self propelling nozzle. It is self-propelling, and does not require the use of ropes, rods, or windlasses. It is provided with a combination steel and monel-metal ball bearing which will not rust or freeze together. The tool is made by the Self Propelling Nozzle Co., 99 Water St., New York City.

Concrete Levelling Target

A laborer with a good eye will level or smooth a concrete slab with very little variance over a distance of 5 ft. if he has points given him which are permanent and ridged. The very simple target shown in the illustration herewith is designed to supersede the wood block ordinarily used for this purpose, and thus to avoid annoyance through the tendency of the block to tip over. The M. & M. Wire Clamp Co., of Minneapolis, is the producer of the special part of this target.

The targets are made up with 60d spikes or quarter-inch rods cut to the desired length. It is also advisable to put on a small piece of wire, as shown in the cut, for a flag in case the top of the pin is covered with concrete. This eliminates losing the pins when they are lined up both ways.

These targets are prepared by common labor on a bench, and a man will make up five or more per minute



M. & M. Target Set Up Ready for Use.

to the exact height desired. In view of the variability of slab thickness from job to job, this complete adjustability is of great advantage. The targets can be set with an instrument

if desired. If desired they can be used as pivot points to turn on with screeds to level the concrete.

An improvement consists of a small cap which fits on top of the quarter-inch rod and is inserted in 5-16-in. holes 4 ft. on centers in 1x2-in. strips 12 ft. long. This permits 4 targets to each 12-ft. strip. The strips are set up parallel to each other from 10 to 12 ft. apart, so that a straight edge can be used on top of them to level the concrete. By using these caps and targets with quarter-inch rods and 1x2-in. strips a contractor in very little time can set up very accurately a screed gauge. After the concrete is leveled the strips can be lifted off the targets and moved forward. With this method the screed gauges can also be set with an instrument, which is an additional advantage, as slabs can be accurately leveled or sloped.

Auxiliary Transmission System for Increasing Power of 1-Ton Truck

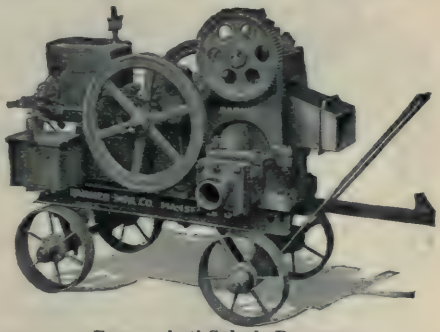
An auxiliary transmission system that is claimed to double the power of the Ford 1-ton truck has been brought out by the Tractor-Train Co., of Indiana, Connersville, Ind., a Ford truck equipped with this transmission has four speeds forward and two reverse. The principal feature is the intermediate speed which is half way between the present Ford high and low, 100 per cent more powerful than the high and twice as fast as the low,

Truck Equipped with Moore Transmission.

without holding down the foot pedal. This intermediate gear is a direct drive from the high speed clutch and eliminates the constant relining of the transmission bands. In addition to the intermediate speed, the power of the low and reverse speeds is increased 100 per cent. This in no way changes the original high, low and reverse, nor the driving method of the Ford. The transmission has a positive neutral point which allows easy cranking by eliminating the drag on the Ford clutch. In the intermediate speed it is stated to be possible to carry very heavy loads over the most difficult roads and up steep grades without overheating or racing the engine. The transmission system can be installed easily with aid of only an ordinary hacksaw and the regular Ford wrenches. It is bolted directly onto the differential housing and all the original Ford parts are retained throughout. It does not alter or interfere with the original Ford mechanism in any way. It makes no change in the method of operating the regular Ford foot pedals—but when once installed becomes a permanent part of the car.

"Anti-Splash" Pumper

A compact trench pump named the "Anti-Splash" by its makers, The Barnes Manufacturing Co., of Mans-



Barnes Anti-Splash Pumper.

field, Ohio, is shown in the cut below. It is furnished in single 3-in. or single, double or quadruple 4-in. sizes, mounted on skids or trucks. The double or quadruple sizes are arranged for separate suctions from more than one excavation at the same time, or for one common suction, as may be desired.

Among the special features distinguishing this pump are:

One-piece unbreakable drop forged steel crank shaft.

Spring loaded suction and discharge valves.

Interior of the pump can be cleaned through hand hole.

Diaphragm can be replaced in 20 minutes without removing jack.

Suction valve can be removed without disturbing hose.

Can be converted into the "Odofor" Pump by simply interchanging seven parts.

Anti-Chatter Bump Machine

The device here shown attached underneath a truck has been used with much success in the maintenance of earth and gravel roads in Michigan. It is the invention of Mr. David E. Burns, of Grand Rapids.

According to published reports work done by this machine costs only one sixth of what it was costing under the methods immediately preceding its introduction. Its field of usefulness is described as follows:

It will plane the road, obliterating chatter.

It will gather loose gravel from the shoulder, spreading it evenly over the road in one continuous operation.

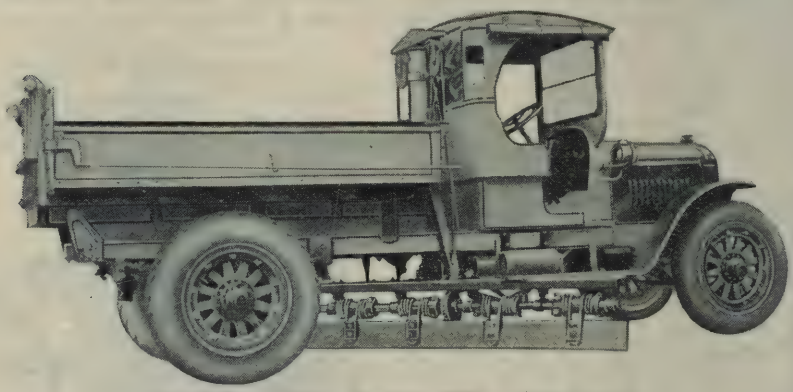
It can be used for finishing subgrades and for leveling gravel on new roads. When not in use it may be rolled up under the truck so as to be out of the way.

It will remove snow and slush from city streets and country roads.

As shown in the accompanying photograph it carries a coiled U-shaped spring, which is fastened around a sleeve, the rock shaft passing through the sleeve. The sleeve being made fast to the rock shaft by U-bolts, and should the springs ever weaken—which all springs do—added tension can be had by simply loosening the 2 U-bolts, turning the jacket around and increasing the tension as desired.

Also the adjustment of fastening the spring to the blade in such a way that the blade can be let down as worn out, thereby using up practically the entire blade, and can readily be tilted so that the road can be crowned or decrowned. In front, are blocks on hangers with set screws letting the whole blade be lowered or raised at will, and when the device is not in actual operation, it can be raised by a hand wheel operated from the driver's seat and rolled up under the truck, and the truck can be used for any other work without interference.

These scrapers can be installed on any truck and can be driven at the rate of eight to ten miles an hour, and do perfect work. By reason of the long chassis and the heavy weight on top of it, it pares and smooths the road, doing away with chatter bumps and waves.



Anti-Chatter Bump Machine With Blade Lowered.

The manufacturer is the Grand Rapids Road Equipment Co., Houseman Building, Grand Rapids, Mich.

The Mound Traffic Marker

The traffic marker illustrated herewith is the E-48 made by the Mound Traffic Equipment Co., No. 7 Huntington National Bank Bldg., Columbus, Ohio.

The E-48 stands 5½ in. above the street level at the highest point.

The dual lighting unit and subbase is self-contained under the marker with sufficient clearance above the street level to eliminate the necessity of excavation. There are no water trap and no water pocket under this marker. The electrical connections are all high and dry. The marker is water tight inside and offers no depositing place outside.

Lens is bolted into place by a specially developed metal to metal gasket,

and projects a concentrated beam of light in all directions.

Enough heat is generated under the lens to keep ice and snow melted in the coldest weather.

The Lens is so placed that dirt and dust blown in on it will blow through and out the other side. There are no sharp projections to cut tires should marker be accidentally struck.

The angle of the slope of the sides

Mound Traffic Marker.

of this marker were very carefully developed after exhaustive investigation, research and tests.

Speed-up moving pictures were made to aid in determining the concussion and rebound of vehicles of different sizes and weights striking the marker at various speeds. Imprints were also registered of the treads of tires passing over the devices on test. At speeds of 30 miles per hour, imprints from the treads were as pronounced leaving the marker, as was the approach on the opposite side.

Somerville Gasoline Hammer Drill

A gasoline impact drill of the air hammer type known as the Somerville

Somerville Drill Complete with Various Tools.

Gasoline Hammer Drill is now manufactured by the Pennsylvania Gasoline Drill Company of Philadelphia, Pa.

This drilling unit is a self-contained gasoline hammer for one man operation. It is also readily carried by one man. It was originally developed for drilling rock, but, because of its portability and simplicity, is claimed by its makers as adaptable to a great variety of uses including: cutting asphalt streets, breaking concrete, picking hard earth, ramming back fill in trenches, removing granite or wood block, drilling foundations, drilling through walls, driving tie spikes, ramming tie ballast, mining operations, etc.

The full weight of the Somerville Drill unit is 70 lb. It consumes about 1½ gallons of gasoline per day in use.

An Improved One-Man Saw

R. W. Graves, 2306 Chafee Ave., Aiken, South Carolina, is the maker of the one-man saw shown in the

Graves One-Man Saw in the Forest.

illustration following. The design of the frame and handle provides easy and efficient operation under all conditions ordinarily encountered. The total weight of the saw is 6 lbs., and it folds into compact space for carrying in the woods. This tool is adapted to all the ordinary uses to which one-man saws are put, and in addition it extends the field of one-man operation.

The Penberthy Automatic Cellar Drainer

The cellar drainer illustrated herewith and manufactured by the Penberthy Injector Co., of Detroit, Mich., is a device of admirable simplicity in both construction and operation. It operates under either water pressure or steam, and although its commonest use is in the drainage of cellars, it is adaptable to service in any place where water accumulates.

The device as shown is provided with an ejector or siphon jet, to which is attached a quick-opening,

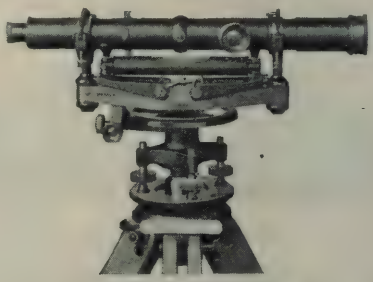
Automatic Cellar Drainer.

float-controlled valve. The drainer is placed in the sump, or place where the water or seepage collects, a line from the city water supply attached at one side, and a line leading to discharge point (sewer, gutter, or wherever it may be) to the other side. As the water rises in the pit the float is raised and when the right height is reached the valve is opened instantly, allowing the city water to flow through the ejector, cause a suction, and carry the sump water with it to the discharge. As the water goes down the float follows, and when the low point is reached the valve closes to remain closed until enough water collects to again raise the float, when the whole operation is repeated, and the drainer continues this work without any attention whatsoever.

Convertible Level

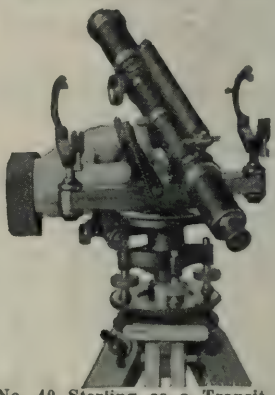
The latest model of convertible level and transit, made by the Warren-Knight Co., 136 North 12th St., Philadelphia, Pa., is illustrated herewith. This is known as the No. 40 Sterling.

It consists of a high grade level so designed that it can be changed in 10 seconds for use as a transit without the use of detachable parts.



No. 40 Sterling as a Level.

Specifications for this instrument are, briefly: Telescope 13½ in. long, balanced and dust-proof throughout, with 1¼ in. aperture, clear field, high power and abundant light. It will show objects clearly up to within 4 or 5 ft., making it particularly useful on building and highway construction work. The convertible uprights fold down when not in use, in which posi-



No. 40 Sterling as a Transit.

tion the instrument is free from projections, affording a full view of the fifth level vial and a clear line of sight over the telescope, and permits of the telescope being rotated in the Wyes for testing the adjustments.

The Wye Clips are secured by patented self-contained quick-opening lock screws. A positive stop pin is provided for securing the cross hairs

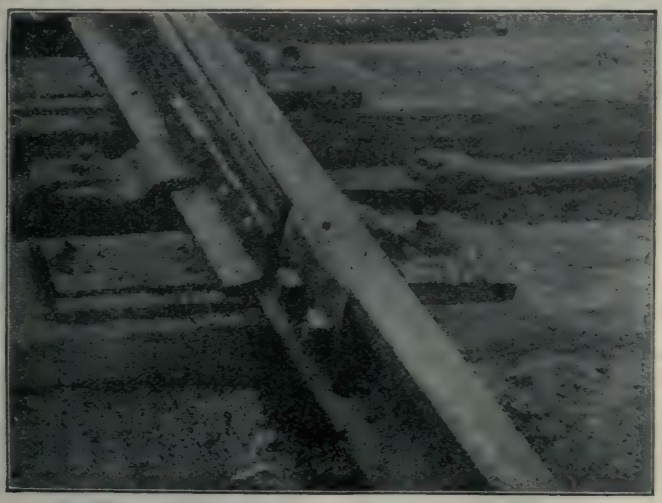
in perfect vertical and horizontal alignment.

The level bar and center spindle are cast in one piece of special formula hard government bronze. Other essential features of this combination instrument adapting it especially to present day requirements are shifting plate providing full ¾-in. adjustment on tripod (for quickly setting over any given point), non-cramping leveling head, leveling screws provided with permanently attached ball socket shoes. The graduated horizontal circle is held by spring tension and can be instantly set to zero, eliminating the necessity for addition or subtraction in laying out or measuring angles. The vernier, which reads to five minutes, is conveniently located at 45° to the line of sight.

There are no removable parts as it is entirely self-contained, consisting of two permanently attached hinged uprights which, when in use, are secured in place by a downward thrust of the lock lever within the triangle of a three point support. Spring trunnion clips provide sufficient friction to hold the telescope in any desired position in the vertical plane, through a range of 45° above or below the horizontal.

New Guard Plate for Railway Switches

One of the most expensive items of upkeep in railway maintenance of way is the repair and replacement of switch points. A device for the protection of the switch points has been placed in production by J. R. Fleming & Son Co., Inc., Scranton, Pa. It is designed to reduce the wear on the ends of the switch point; to avoid wearing the extremities of switch rails to a cutting edge; to reduce the shock of impact on the switch rails, and to overcome the possibilities of derailment on switches. It provides a guard plate which has an upper outwardly curved surface and which is rounded over to approximately the shape of the head of the railway rail. Chamfered corners are provided to receive the impact of the flange and thrust it laterally to separate it from the inner side of the rail head. Four bolt holes are formed in the guard plate to receive the fastening bolts, and the heads of the bolts rest in a channel plate made to conform to the space between the flange web and the head of the railway rail.

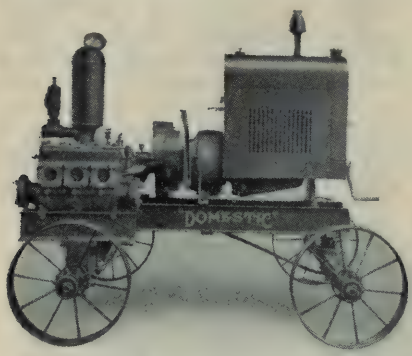


Mack Railway Switch Point Protector.

High Pressure Triplex Pump

The Domestic Engine & Pump Co. of Shippensburg, Pa., has recently placed on the market the unit shown in the illustration herewith.

The engine speed can be so regulated that any quantity of water from 40 to 60 gallons per minute can be delivered. With a vertical elevation of 100 feet in the line 40 gallons per minute can be delivered through 3 miles of 2-inch pipe or 60 gallons per minute through 4½ miles of 2½-inch pipe.



New Domestic Pump Unit.

The engine is a Le Roi 4 cylinder, 15 hp., developed especially for industrial use, and equipped with radiator, cooling fan, magneto, governor, air filter, carburetor, etc.

There is a friction clutch, thus permitting starting and running of engine, for inspection or adjustments, free of the pump and gearing.

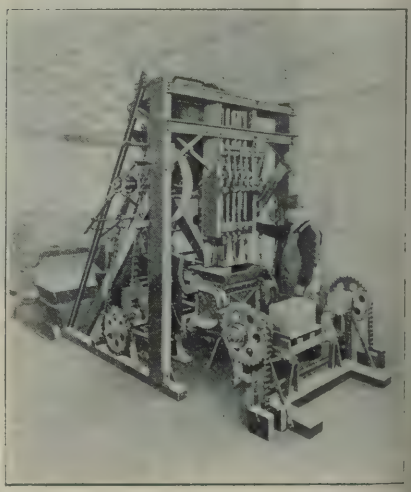
A very efficient radiator and air circulating fan insure proper engine cooling.

All gears are machine cut. The speed reduction gears that run at highest speeds are enclosed in metal housing, are made of special alloy steel, heat treated and run in oil. The slow speed pinion and gear that drives the pump crank shaft are the only ones not in housing. These gears have heavy stub teeth and the driving pinion is mounted on a shaft that has an outboard bronze bearing mounted on the pump frame. A control lever attached to governor gives the operator a choice of a wide range of speeds.

The complete unit is mounted on a truck having 24-inch steel wheels with 4-inch tires and is equipped with pole, trees and neck yoke for two horses.

New Concrete Block Machine

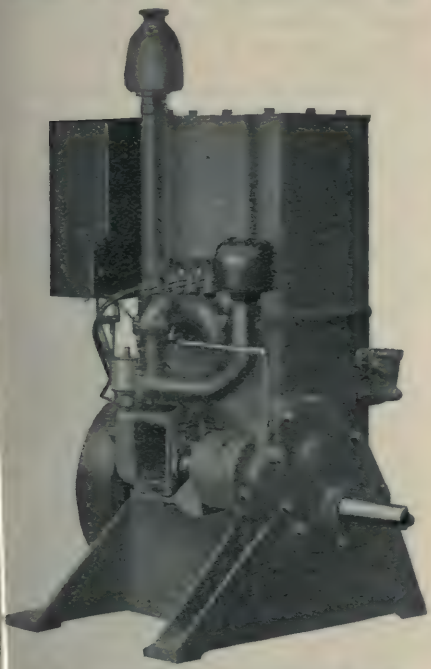
A new machine for the manufacture of concrete blocks has been brought out by the Ideal Concrete Machinery Co., Cincinnati, O. The principle of this machine is a carefully balanced mold box which rolls on a track. In the loading and tamping position, the mold box is back under the tamper, and the scraping hopper is forward over the box. The operator handles the tamper in the regular way, throwing in all the tamp feet at once, at the same time feeds the concrete into the box, using the standard conveyor and feeder for this purpose, as shown. As soon as the tamping is completed, the scraping hopper is pulled back by power, carrying the surplus concrete back on to a plate ready to be used in the next block. The mold box is then rolled over into position. The operator presses a foot lever which throws in a clutch shown on the end of the tamper shaft, and this, by means of cams, forces the block out of the mold box downward onto a pallet placed on a counterbalanced table. As soon as the block is stripped, the mold box is rolled back and the scraping hopper brought forward for loading, and the operation repeated. While this block is being made, the off-bearer carries away the block just completed and places an empty pallet on the table ready to receive the next block.



View of New Roll-Over Machine After the Block Is Stripped

Two New Le Roi Engines

The Le Roi Company of Milwaukee, Wisconsin, builders of light weight, heavy duty engines, have placed on the market a one cylinder 3 to 4 hp. engine and a two cylinder 5 to 8 hp. engine. They are of the hopper cooled



Le Roi Light Weight Heavy Duty Engine.

type, but are distinguished by their peculiarly light weight. This does not mean that they will not give good service, but rather due to correct design as well as the use of high grade steels and a large amount of cast iron being eliminated, the strength is placed in the wearing parts, such as crankshaft and bearings.

The single cylinder engine weighs 335 lbs. while the two cylinder engine weighs 400 lbs. All the reciprocating and rotating parts of these engines are balanced, which makes them operate very free from vibration. Naturally this is a desirable feature where the engines are used on portable equipment, as absence of vibration saves the equipment as well as the engine and guarantees longer life.

These engines are of the vertical type which permits of enclosing the cylinder and thereby reducing wear. All the other vital wearing parts are fully enclosed and properly lubricated by pump that forces oil under pressure to all bearings, and also the splash system of lubrication.

These engines have removable bearings that can be taken up by means of shims, and are so designed that the hopper head is removable, a feature that is found in no other hopper cooled engine in the country. This feature alone will save a great deal of time and money, when the user cleans out the carbon or grinds in the valves, which work is necessary on any gas engine.

A float type carburetor and high tension magneto of the latest improved design are used, which guarantees easy starting under all weather conditions. An enclosed, flyball throttling type governing running in oil, properly governs the speed. On tests that have been made, these engines have shown remarkable fuel and oil economy. In the design of these engines the makers placed dependability foremost among the requisites.

Special Asphalt Wagon

The view below shows one of a group of wagons recently purchased by the Rock Asphalt Co. of Buffalo from the Watson Truck Corporation of Canastota, N. Y.

These wagons are built to handle full 3 yds. of material and are equipped with roller bearing axles; lined with steel and asbestos. They

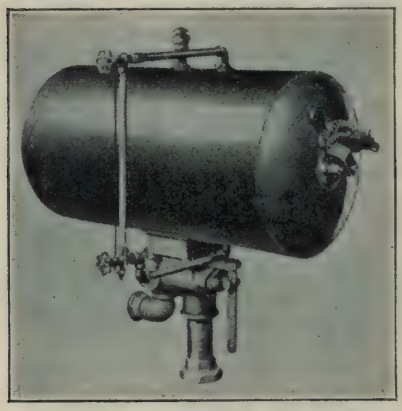
Watson Asphalt Wagon in Service in Buffalo

are hauled at speeds of from 8 to 12 mi. per hour by Fordson tractors.

While the wagon here shown is equipped with steel tires, the manufacturers furnish the same type with rubber tires when desired.

New Water Measuring Tank for Concrete Mixers

The new water measuring tank, designed by The T. L. Smith Company of Milwaukee, Wis., for use on its concrete mixers and pavers, is unique in the device by which the water from the tank is measured. This device consists of an open-top trough, pivoted at both ends within the water-tight outer shell of the tank. By tilting this trough at different angles, it is made to hold more or less water and in this unusual way to regulate the amount of water that can be drawn from the tank.



T. L. Smith Co. Water Measuring Tank.

The action of this trough can perhaps be more easily understood by taking up the operation of the tank, step by step. Let us consider that the trough is in an upright position. The operator first allows water to run into the tank until it is full. Then, as soon as he is ready, he opens the valve at the bottom of the tank and allows the water to run out of the tank into the mixer drum. But the water that is held in the trough cannot run out. The amount of water that does run out is equal to the tank full less the amount held in the trough. Tilting the trough so that it will retain less water permits more water to flow from the tank. When the trough is tilted to a position where it will no longer hold any water, the entire capacity of the tank can be drawn off.

A short arm at the end of the tank enables the operator to set the trough in the position that will allow just the right amount of water to be drawn off for each batch. A graduated sector, along which this arm rotates, indicates the amount of water being used. A lock is provided to lock the arm at any point along the sector if desired.

The water enters and empties from the tank through a 2½-in. valve located at the bottom of the tank. This large valve insures fast filling and emptying.

In place of the usual three-way valve the new Smith tank is equipped with a piston-type, two-way valve. The piston operates horizontally and the seating surfaces, which are rubber and finished cast iron, are in a vertical position. This makes it practically impossible for dirt to cling to the seating surfaces because the incoming and outgoing water is continually washing them clean. Any dirt that may be caught in the valve will drop to the bottom of the valve housing where it can do no damage and from which it can be drained off occasionally through a small plug.

Shovel and Dragline Work in Conjunction on Irrigation Ditch

On the Merced Irrigation District in California two excavators made by the Pawling & Harnishfeger Co. of Milwaukee, Wis. are being used by C. R. Adams, contractor. In digging the canal to the necessary uniform grade it was impossible in this case to use a dragline alone as is ordinarily done because the underlying strata was hard pan which a dragline cannot cut.

P. & H. No. 206 Excavator Working on Irrigation Canal in California.

Mr. Adams therefore equipped one of his excavators as a dragline and

the other as a shovel. The dragline goes ahead and digs away the top soil on the cuts and builds up the fills by borrowing. The shovel follows in the ditch cut by the dragline ripping out the hardpan, sloping the banks and leveling the bottom. This combination works very efficiently.

Special Snow Loader

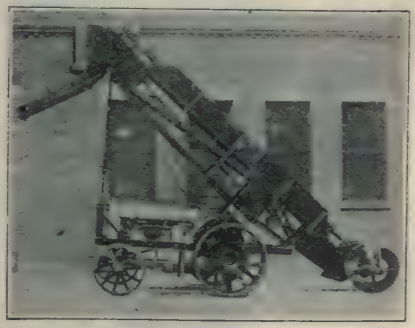
The development of special snow loading equipment in recent years has

Barber-Greene Snow Loader Working at Night.

done much to relieve the difficult situation in which every large city street department in the North finds itself whenever there is a hard winter. The machine here shown working at night is made by the Barber-Greene Co. of Aurora, Ill. It has a record of having loaded more than 3 cu. yd. of snow per minute without any special preparation of the snow for its handling. On one job it was operated in temperatures ranging from 32° above to 5° below zero without any observable change in efficiency. During this same period the snow ranged from slush to almost frozen, the loader apparently handling the different types of snow with equal success. The loader was operated with equal success on bitulithic, wood block, granite and cable pavements.

Fordson Mounted Self-Propelling, Self-Feeding and Self-Crowding Loader

A self-feeding bucket loader mounted on a standard Fordson tractor is the latest product of the N. P. Nelson Iron Works, of Brooklyn, N. Y. In this machine by connecting the elevator directly to the engine, the elevator with its toothed digging spiral runs full speed, while the tractor may be inched backwards into the pile. The spirals level a 6-ft. cut and material once started in motion keeps moving continuously until picked up by the elevator buckets. Buckets are fitted with digging teeth. An overload release gives the operator ample warning of boulders or undiggable material. The capacity of the machine is stated to be 40-yd. per hour of material 2-in. and under that a man can shovel without the use of a pick. A governor is installed to con-



1-Man Truck Loader.

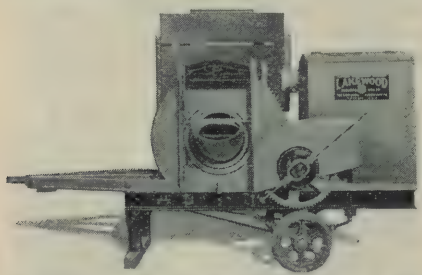
trol the fuel consumption to the actual requirements. The power take-off remains available should the owner require its use for operating other machinery, while the entire loader attachment can be readily removed and the tractor used for other purposes. A swivel or turning spout is attached to the loader, permitting discharge sideways into truck if necessary. 8 ft. 6 in. clearance is given under the discharge chute. The general construction of the machine is substantial. The elevator frame is of truss design. The elevator buckets, chains, sprockets, etc., are in keeping with the regular design of the maker.

Lakewood "Light Seven" Mixer

This mixer, made by The Lakewood Engineering Co. of Cleveland, Ohio, is a lighter type of one bag machine—capacity 7 cu. ft. mixed concrete per batch. It is furnished on either steel tired truck or with solid rubber tires and spring suspension, and is designed as a substantial machine yet one that can be easily moved between widely separated jobs. It has either low charge platform or power loader and water tank.

The wheels, which run on a 2½-in. high carbon, heat-treated axle, are equipped with solid rubber tires and Hyatt roller bearings. The standard equipment includes the structural tongue which attaches to the front of the mixer frame and it is all so designed that it can be easily attached to a mixer in the field.

Folding legs are provided which can be dropped down from under the front of the mixer frame as shown when the machine is set up for operation.



The Light Seven or Type "M" No. 7S Mixer.

The engine house is large and roomy. The charging opening in the drum is unusually large, being 26 in. in diameter. This means quick and easy charging with wheelbarrows. The low charge platform which is hinged to the frame is only 19 in. from the ground and has steel legs which fold up against the platform when the machine is being moved.

The main drive gears are completely enclosed in guards. Grease cup lubrication is provided at all points and the grease cups can be easily reached and attended to.

The frames of the Lakewood Light Seven Mixers are made of 6-in. steel channels, hot riveted, with gussets at the corners. This gives a solid foundation for the mixer drum and platform. The parts will stay in alignment and reduce wear to a minimum. The machine is designed to stand long, hard and continuous service. There is a grease cup on each drum roller and also on the drive shaft. The front axle is of the built-up type and composed of 2-3-in. channels. The rear axle is cold rolled steel shaft 1¾ in. in diameter with a 4-in. face. The rear wheels are 26 in. in diameter with a 4-in. face. The tread is the same for both rear and front wheels.

The Lakewood Light Seven Mixer has an exceptionally large charging opening. It is 26 in. in diameter, which allows plenty of room for wheelbarrow charging. The discharge opening is 17 in. in diameter and the discharge chute is of the same type as used on all larger Lakewood mixers. The large size discharge opening and the steep angle of the discharge chute assures rapid and easy flow from the drum. When not in use, the discharge chute swings out and upward, effectively closing the opening and returning any accumulation of grout into the drum.

A friction clutch is always furnished with the Lakewood Light Seven Mixer. This clutch consists of a steel band lined with hard maple block. One end of the band is fastened and the other end is movable by means of a bell crank. A tighter grip on the clutch can be obtained by turning the screw with an ordinary wrench. A dust cover completely encloses the friction surfaces, greatly adding to the life of the clutch, and a large guard completely encloses the gears.

The drum gear is of semi-steel, cast in four equal parts, which are interchangeable. A segment of the gear may be removed and replaced in a few minutes—a feature of real value on the job.

One-Man Portable Derrick

The Barrett-Cravens Co., 1328 West Monroe St., Chicago, Ill., have produced the small portable derrick which is here shown attached to a gondola car from which it is unloading cast iron pipe. Quickness and ease of installation are the characteristics of this derrick. It is made in two types—the standard for use in building operations, attachment to trucks, etc., and the gondola type for use on cars as here shown. It is adaptable as a permanent installation for loading platforms. For handling long, heavy

materials these derricks are sometimes used in pairs. There are but two major parts—a beam, which includes the hoisting mechanism, and a bore. One man can carry either section and can easily install the derrick alone.

It is equipped with two handles so the operator can push with one hand and pull with the other, the best method for easy and fast operation.

Barrett Portable Derrick Unloading Gondola Car.

General specifications are as follows:

Reach of beam, 3 ft. 4 in.

Maximum lift above floor level that derrick is bolted to, 5 ft.

Height over all, 7 ft.

Capacity of drum, 300 ft. of cable.

Weight, standard type, 285 lbs.

Weight, gondola type, 450 lbs.

The loads and speeds of convenient lifting by one man are: With one strand of cable 300 lbs., 50 ft. per min.; with two strands, 600 lbs., 25 ft. per min.; with three strands, 1,000 lbs., 17 ft. per min.

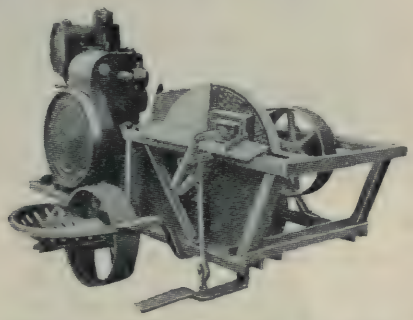
Machine for Salvaging Bricks

The Maroa Manufacturing Co., Maroa, Ill. is the maker of the machine shown herewith for the cleaning and salvaging of bricks from old buildings.

Under general conditions it requires 3 hp. to operate the disc. To take care of exceptional conditions either a 4 hp. water-cooler radiator type Cushman engine or a New-Way air-cooled 5 hp. engine is furnished. Air intake of engines provided with dust cleaners, and all bearings are dust proof.

Clutch is provided on engine pulley, and lever within easy reach of operator is provided so engine can be disengaged if necessary.

The makers have made elaborate tests to determine the best cutting tool, and have found that nothing else does as well as the special white iron used. It not only stands up under the work of removing mortar from used brick, but it is very economical



Model No. 2, Eureka Brick Cleaning Machine.

to replace. The average cost for cutting tools will be less than 8 cents a thousand brick. They are quickly put in place. There are 6 of these V-shaped sections in the disc.

In the illustration the broad side of the brick is in contact with the disc, and is held in place either by foot lever or by hand. When the foot lever is released the plate on the side of the brick drops back and the slanting plate on which the brick rests causes the brick to fall away from the rotating disc.

The operator sits close enough to the ground to pick up the brick out of the pile and toss them to one side when clean. The outfit can be moved right along by the pile by the operator. The mortar from the cleaned brick accumulates at about the edge of the outfit where it can be easily shoveled out of the way or the outfit can be backed off of it if moved to the left, as this end of the outfit swings clear of the ground.

New Drum Type 1-Man Puller

A number of improvements in its one-man drum type of stump puller have been made by A. J. Kirstin Co., Escanaba, Mich. The development of a four-speed puller recently announced by the Kirstin company has greatly increased the field in which the puller can be advantageously used. For maximum power speed must naturally be sacrificed to some extent in an outfit which is dependant upon a single man for its power. But with its present range of three forward speeds and a reverse speed, power and speed can be regulated according to need just as they are in an automobile. The reverse speed of the new drum type puller is stated to make it especially suited for use as a hoist, since the load can be lowered under full control just as easily as it can be raised.

1-Man Type Stump Puller.

A New ¾-Yard Gasoline Shovel

A new ¾-yd. gasoline rope-thrust revolving shovel, known as the 20-B, has just been announced by the Bucyrus Company, South Milwaukee, Wis.

This shovel contains the same features which are embodied in their 30-B gasoline machine which has been on the market for the past year.

Like the 30-B, the feature which makes this machine unique among shovels of its type is the rope-thrust arrangement, patents on which are held by the Bucyrus Company, which not only does away with the necessity of engines or other complicated mechanism on the boom, but at the same time gives this shovel a drive behind the thrust more powerful than it is possible to obtain with a steam shovel of the same size, since the whole power of the main engine is behind it.

This device has proved itself on the 30-B shovel under the toughest digging conditions in all parts of the world.

Briefly stated, the shovel is driven by a single, rugged, slow-speed gasoline engine. The motions of the dipper handle are controlled by a small drum on a shaft under the boom, which shaft has keyed to it pinions for engaging with the racks on the handle. The drum is turned either way by two ropes around this drum in opposite directions, both ropes leading to drums in the main machinery.

The striking fact about the performance of this shovel is the ease with which the operator can control the motions of the dipper, even to shake it to relieve it of sticky material.

This shovel may also be had with high lift or extra high lift booms, or with dragline, clamshell excavator or crane attachments.

The control is exceedingly simple, and the machinery arranged with convenience of the operator in mind. Whatever clutches are necessary are sufficiently large to obviate the danger of burning. The caterpillars and frame in general are the same as the 20-B steam machine.

Explosives Used In April, 1923

Sales of explosives in the United States in April, 1923, reported to the Bureau of Mines by manufacturers, amounted to 598,622 kegs of black blasting powder, 5,443,735 lb. of permissible explosives, and 23,466,571 lbs. of high explosives other than permissible. Each of these figures represents a large increase over April sales during the past four years with the single exception of black powder sales for April, 1920, which amounted to 611,979 kegs. The figures presented are based upon reports to the Bureau of Mnies from manufacturers whose sales amount to about 90 per cent of the total sales of explosives in the United States.

2½ Ton Dump Trailer

The trailer here shown behind a Fordson is made by The Miami Trailer Co. of Troy, Ohio. It is especially designed for road and street work—either construction or maintenance,

Miami Fordson Trailer.

but is also suitable for building and other construction. It is adapted to the hauling of dry materials, concrete mix, or hot asphalt. This trailer is distinctly a high speed machine for use singly or in trains.

Model 14-L Jaeger Mixer

The Jaeger Machine Co., Columbus, Ohio, has added to its line a model designated as the "14-L." This is a larger size mixer, built along the same lines as other Jaeger models.

The machine has been given a thorough tryout, under conditions for which it was designed, to assure complete satisfaction before being offered to the trade. For the past year this model has been through the experimental stage, and has now been adopted as a standardized unit.

The Jaeger 14-L has a capacity of 14 cu. ft. per batch of mixed concrete and will accommodate 21 cu. ft. of unmixed materials, using 3 cu. ft. cement, 6 cu. ft. sand and 12 cu. ft. stone. The mixing drum is the standard Jaeger tilting type, for quick loading and discharging. Drum is 52 in. in diameter and 44 in. deep.

The engine is 4-cylinder, 15 h. p. automobile type—an engine known to be satisfactory for heavy duty service and furnished with reduction gears to operate mixer at proper speed.

The loader bucket is easy to load, and unloads without pounding. It is lifted to unloading position by quick-acting cone clutch—equipped with brake for perfect control.

Yoke to carry mixing drum is of hollow design—semi-steel.

Water tank is of the Jaeger tip over type—of ample size for full capacity wet batch—automatic in action.

Front wheels, 28x5. Rear wheels, 30x6. Truck 72 in. wide. Top of truck made of 6 in. I-beams. Frame of mixer made of 6 in. I-beams and 4x4 angles—all steel construction. Heavy in design but light as possible in weight.

Distance between axles, 88 in.

Distance from floor to center of top shaft, 96 in.

Distance from floor to extreme top of loader bucket when raised up to dumping position, 128 in.

Width of loader bucket, 45 in.

Diameter of water tank, 16 in.

Extreme width with loader bucket down, 125 in.

Weight complete, 6,645 lbs.

The discharge is semi-automatic and drum is evenly balanced—controlled by operator at will with little effort.

Ammite—A New Explosive

The Atlas Powder Co. of Wilmington, Del., has recently brought out an explosive named "Ammite" which it claims to possess all the desirable qualities of dynamite in strength, velocity, water-resistance, sensitiveness and stability combined with the additional advantages of being non-freezing and of not causing headaches when handled.

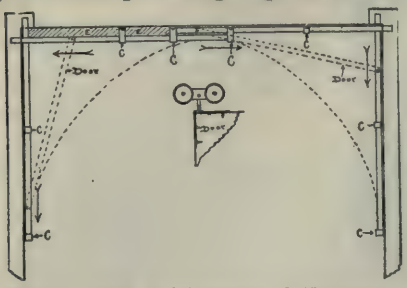
In addition, it is equally satisfactory in either summer or winter, and may be kept in proper storage indefinitely without harming its strength, sensitiveness and stability in the least.

Ammite is graded as to its percentage strength in the same manner that the various forms of dynamite are graded. It is made in six grades—75, 60, 50, 40, 35 and 30 per cent—sufficient to meet practically every requirement encountered in any kind of blasting, be it mine, quarry, clay pit or construction work, either above or below ground.

Garage Door Arrangement

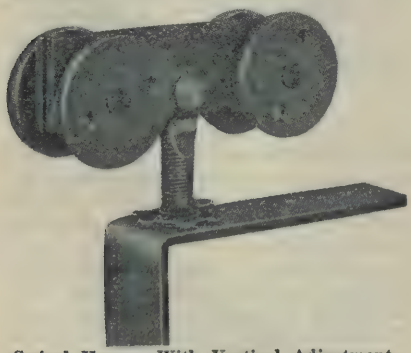
From The American Builder for July

Many of the modern garage requirements cannot be readily satisfied by the common methods of hanging doors. Garage doors demand special consideration, and illustrated is an equipment specially designed and which is used quite extensively on public and private garage entrances.



Plan of Doors and Diagram of Movement.

The two edges of the door are hung independently by a swivel hanger, one mounted in a trackway over the opening and the other in a trackway along the side wall. In closing these doors go snugly up against the casings and are practically as tight as a swing door. When open they stand back against the side wall. The tracks cross at the center (side track under) and each enters the wall about four



Swivel Hanger With Vertical Adjustment.

inches to provide space for the hanger trucks inside. For double doors the front track is in sections, one back of the other, so that the doors overlap each other at the center in closing. This gives room in the independent trackways for the hanger wheels which project well beyond the door edges.

A tight job is obtained however, by filling in behind the track as indicated and properly arranging the jamb and sill for this door. The hangers have vertical adjustment, and have hardened ball bearings, and are made in two sizes, for a door weighing up to 350 pounds, and a door weighing up to 1000 pounds, respectively. Doors may be hung in pairs also by this system, as illustrated in the diagram. It is particularly useful where the opening is wide, and the door or doors must be kept inside the building instead of being opened out.

Highway Widths

Editorial from the September Highway Bulletin of the South Carolina Highway Department.

In the old days when horse drawn vehicles constituted the traffic, a road surface 15 ft. wide was considered adequate on all suburban roads, and in many cases a surface 12 ft. wide was sufficient. The same roads now need surfaces at least 18 ft. wide, and in many instances 24 ft. Of late years the standard highway requirement has been 8 ft. of width per stream of traffic. This naturally resulted in the 16-ft. standard width of roadway, so long and so generally employed throughout the country, except where traffic was of extreme density. It is thought that now on main through lines of travel where the number of vehicles per day is sometimes as high as 3,000 the width should be at least 20 ft., with a sufficient width of suitable shoulder to make a total available width in emergencies of 26 ft.

The American Roadbuilders' Association at its 19th annual convention in Chicago, Jan. 17-20, 1922, went on record as favoring a pavement width of not less than 20 feet for all truck highways or roads carrying dense traffic. This resolution had as preamble that it was the experience of road engineers that 18-ft. pavement widths carrying dense traffic in the vicinity of large cities were not adequate. The reason for the endorsement of 20 ft. as the standard minimum width was principally because in addition to occupying space actually needed for traffic. the shoulders of narrow concrete roads are much more badly damaged by heavy vehicles overrunning on them, which also jeopardize the edges of the concrete, which is likely to be much more broken than when the traffic is retained within a foot of the edge. The increased width of bitu-

minous roads will also tend strongly to prevent the development of ruts that are found in narrow roads.

One chief engineer stated that the cost of shoulder maintenance of an 18-ft. roadway, when added to the cost of the roadway itself, greatly exceeded the cost of a 20-ft. road and its maintenance. He thought the width of the road should be increased with the increase of traffic, allowing at least 10 feet for each lane of traffic.

The chief engineer of the Massachusetts highway department reported that Massachusetts is now specifying a 20-ft. standard for main highways and preparing for 26-ft. roads, as on the Boston highway, where the foundation is 26 ft. wide, although the present wearing surface is only 20 ft. In districts where not more than 200 or 300 vehicles pass daily, 18-ft. width suffices unless the traffic is chiefly of motor trucks.

Motor trucks 8 ft. wide over all are now in service on many highways and two of them cannot safely pass on an 18-ft. roadway.

An English engineer was quoted as saying that roads near New York City should have a minimum width of pavement of 30 ft., adding that if American traffic continues to grow, roads 150 ft. wide, such as now exists between London and Edinburgh, will be required on American main trunk highways and especially near large cities. An official of the United States Bureau of Public Roads advocated the minimum width of 20 ft. and stated that bridges were now recommended to be 22 ft. and whenever possible 24 ft. in width.

The Federal law now fixes a minimum width of 18 ft. for the surface of roads on the primary systems of the several states, and in general a minimum width of 18 ft. for hard surfaced roads is recommended by the Bureau of Public Roads of the United States Department of Agriculture. The maximum width of truck body generally permitted is 8 ft., and 5½ ft. is the ordinary clearance width of automobiles. "At an average speed of 30 miles per hour it is unreasonable to expect the driver of an automobile to drive with his wheels closer than 1½ ft. to the edge of the pavement. For trucks at an average speed of 15 miles an hour, this distance should not be less than 1¾ ft. on account of the great width of the rear wheel. Three feet seems to be a minimum safe clearance between bodies. Inasmuch as a certain amount of truck traffic is to be expected on all main country roads, the minimum width of surface should be 18 ft. to provide the above clearance."

Where the frequency with which trucks pass each other becomes a big factor, as in the neighborhood of large cities, the minimum width of pavement should be 20 ft., to provide a clearance of 3½ ft. and a safe distance of wheels from edge of pavement.

In the South Carolina highway act, the width of trucks is limited to 7½ ft., but as traffic develops the increased width will without doubt be authorized and, therefore, the 8 ft. width should govern.

In the opinion of the state highway engineer, the conditions in South Carolina are such that an 18-ft. pavement is sufficient for most locations. A less width than 18 ft., however, is not considered desirable for any so-called permanent type of pavement; because, when the traffic warrants such a pavement, it will undoubtedly soon warrant the 18-ft. width.

Bonus System for Workmen on Road Job

To stimulate the interest of the workmen and encourage team work, the Kaiser Paving Co., of Mt. Vernon, Wash., inaugurated a system of wage payment based on the amount of work accomplished. The system was inaugurated on a 7.7 miles concrete paving job on the Pacific Highway in Skagit County, Washington. We are indebted to the Western Highways Builder for the following details:

The paving on this contract was under the direction of the Washington State Highway commission and was 20 ft. wide, 6 in. thick at the sides and 7½ in. thick at the center. It was found that twelve 30-ft. slabs constituted an average fair day's work, and the system adopted, offered each man a fixed bonus for every additional slab placed during the day.

The piece rate for each man per slab was fixed at his day's wages divided by twelve, the number of slabs considered a fair day's run. Only the mixer operator and the foreman were paid a straight salary and bonus

basis. Other men in the mixer crew were paid as follows:

Preparing Subgrade—
3 men at 46½ ct. per slab.
Wheelbarrow Men—
3 on sand at 46½ ct. per slab.
8 on gravel at 46½ ct. per slab.
2 cement men at 46½ ct. per slab.
Placing Concrete—
2 spreaders at 50 ct. per slab.
2 template men at 50 ct. per slab.
1 finisher at 75 ct. per slab.
Miscellaneous—
1 material spotter at 46½ ct. per slab.
1 general man at 46½ ct. per slab.

Curing the pavement was done under sub-contract. Aggregates were hauled partially under contract at 25 ct. per ton mile and partially by the contractor's trucks, the driver being paid by the hour. All cement was hauled by contract, 16 ct. per barrel for all hauls up to 2 miles with 5 ct. per barrel extra where the distance hauled exceeded 2 miles.

Under this system excellent progress was made, the average daily run being 16 slabs per 8-hour day. The same payment system was in force on other jobs undertaken by the same contractor and a friendly spirit of rivalry between the various crews was encouraged. It was the ambition of each crew to "break the record" and each crew was notified of the other crew's progress for the preceding day.

The workmen were thus able by individual effort to increase their day's wages and the crew would not allow a drone in their midst. The contractor also had the advantage of knowing just what his labor charges were per slab and the assurance that the utmost possible progress was being made, consistent with standard workmanship.

A 4-sack Koehring mixer, holding 24 cu. ft., loose measurement per batch was used. A. B. Ordway was the Kaiser Paving Co.'s superintendent and Richard H. Wilson was resident engineer for the State highway commission.

Canadian National Railways Lets Contract for Work at Fort William, Ont.

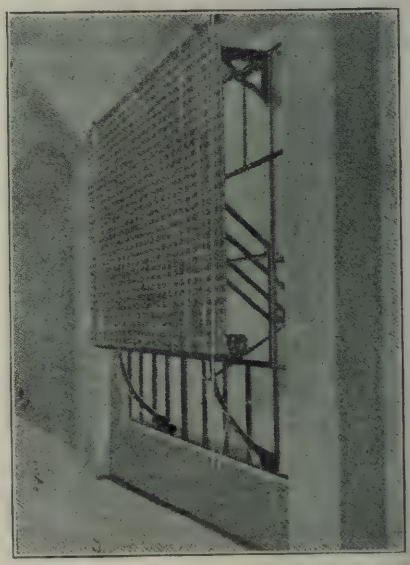
J. C. Milligan, Fort William, Ont., has been awarded a contract by the Canadian National railways for main line alterations immediately west of Fort William. The contract will be in connection with the double-track construction from Mokoman west for three miles to connect with the existing Canadian National main line.

New Type of Ventilating Shade for Center Swing Sash

From The American Builder for July

The center swing steel sash so popular in the fenestration of various types of buildings no longer presents any obstacles to proper shading against too strong or hot sunlight.

A manufacturer is producing a shade which is applied direct to the steel sash, eliminating the expensive and troublesome boring of the concrete or brick walls, and whose construction of stained wood strips, twine-woven, tend toward easy operation and lasting qualities over a long period of use.



Shade in Place Over Tilting Sash Window.

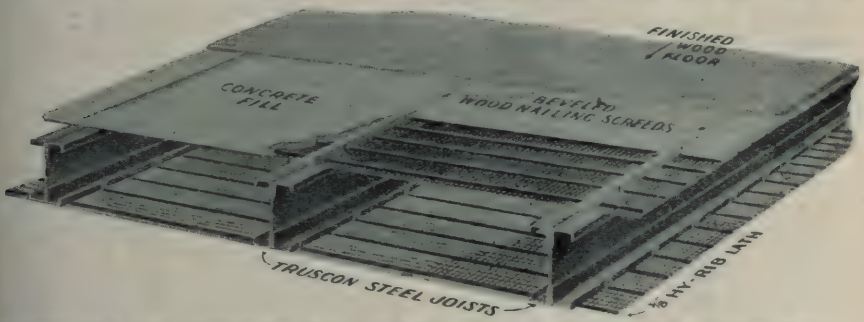
Naturally, a shade to be properly considered as such must be of a type which does not interefere with the ventilator, even while it shields against the light. Its lower portion must be out of the way of the workers passing by, and out of the way of possible flapping against machinery. The shade illustrated is suspended from a bracket attached to the steel ribs, and is automatically brought in flush against the wall at the base of the sash.

Steel Joists

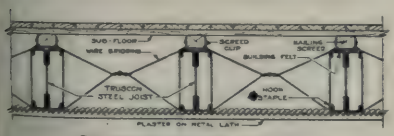
The two cuts herewith illustrate the use of light steel joists now being made by the Truscon Steel Company of Youngstown, Ohio. The advantage of this material lies in the substantial, non-combustible construction which it furnishes at a cost much below that of ordinary structural steel. The manufacturers have just issued a 32 page, profusely illustrated volume entitled "The Steel Joist Data Book" in which very full information is given on the properties and uses of these joists. It is stated therein that floors of this construction weigh from 40 per cent to 70 per cent less than do other fireproof floors. Regarding fireprof qualities the following statement is made:

"Structural steel shapes, because of their process of production, have their fibres distorted in their manufacture. When heat is applied, around 700 degrees, the internal stress is released and the steel member becomes distorted and twisted in shape. The process of manufacture of Steel Joists causes no internal stress, with the result that ample strength is available up to temperatures around 1000 degrees to 1200 degrees, with no tendency to twist or distort. Repeated fire tests have proven that ⅞ in. of cement ceiling plaster will protect Steel Joist Construction against temperatures of as high as 1700 degrees, such conditions developing less than 550 degrees around the joists. The fireproofness of Steel Joists has been developed not only in tests but in actual fires in comparison with other constructions."

The sectional perspective shows a wooden floor laid on a concrete filler with wooden nailing screeds. The right section shows an all-wooden type of floor. Numerous solid concrete and other types of floors, as well as roof construction with the joists as purlines, are illustrated in the data book.



Truscon Steel Joist Construction With Wood Floor Finish. ⅜-In. Hy-Rib Lath for Floor and Ceiling.



For Joist Spacings Up to 24 inches

Arrangement for Wooden Floor and Joist Spacings Up to 24 Inches.

The Ohio Leader Road Machine

The Ohio Leader, made by The Oberlin Machinery Co., Oberlin, Ohio, is a team machine only, sufficiently strong to be operated with two heavy teams. It is equipped with a digger or without. The digger can be operated in conjunction with the blade. The blade is equipped with fenders, and is a highly efficient grader for leveling material or sub-grading. The vertical adjustment of the blade is the latch wheel and chain hoist mechanism. The lateral adjustment is the pin side feature.

The rear wheels are equipped with or without flanges.

Weight complete 1,750 lbs.

The machine is operated from the rear platform with the hand wheels and operating machanism in reach of the operator.

Methods of Grouting in Shaft Sinking

Extract from Article, "Present Practice in Design and Sinking of Mine Shafts," in May Proceedings of Engineers' Society of Western Pennsylvania

By R. G. JOHNSON,
President, R. G. Johnson Co., Pittsburgh, Pa.

The handling of water which is encountered in the sinking of shafts depends largely upon the amount of water and the nature of the rock. Grouting is the only method of preventing the water from coming into the shaft, and today provision for the sealing of water by injecting cement into the fissures of the water-bearing strata is a part of all specifications. Today, all prices in contracts for sinking shafts are based on the assumption that if water is encountered grouting will be started and paid for according to provisions in the contract. Usually grouting is paid for per barrel of cement injected, but it would seem that a method fairer to both parties would be an agreement to pay for the cost of grouting on a basis of cost plus a fee per barrel, the fee to include the use of the contractor's plant, and his profit. The grouting clause and its price today takes the place of the water clause in the contracts of 12 and 15 years ago. This clause in former contracts provided for additional prices per vertical foot sunk in case certain quantities of water were struck, the prices to increase as the quantity increased, but this was an inequitable manner of paying for the cost.

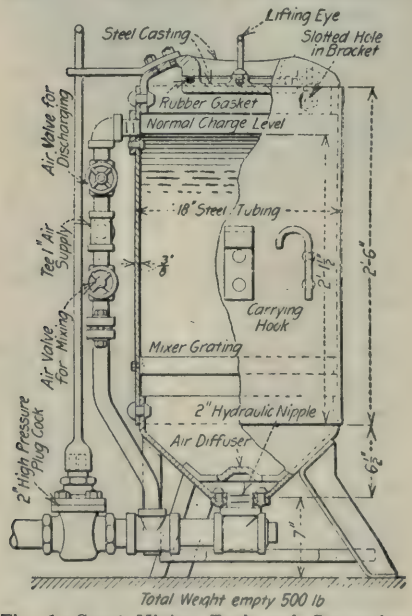


Fig. 1—Grout Mixing Tank and Connections

The fairest water clause for pumping is the one based on paying by the million-ft.-gals. for all water pumped. This form of water clause (in addition to the clause for grouting) was used in the contracts for the shafts and tunnels for the Catskill aqueduct which was completed several years ago.

The First Use of Grouting.—In grouting, cement mixed with water to the consistency of cream is forced into the crevices under high pressure through drill holes in the rock, or pipes through the lining. The process was used first in shaft sinking in this country about 1910 on the construction of the Catskill aqueduct, although in Germany and in Northern France the principle was used several years before in cementing around the outside of the shaft before sinking was started.

Resistance Fundamental Requirement of Grouting.—The fundamental requirement to grouting is resistance. You cannot grout a length of 2-in. pipe open at both ends, but plug one end and you can pack it full of grout under pressure, and it will be solid and very dense.

If the ground 4 or 5 ft. above the stratum is solid, the grouting can be done very easily. If the strata above the water-bearing seam are full of crevices, naturally or through shattering, these cracks will allow the grout to work out because there is not enough resistance to the pressure of the grout. Such a condition will often take care of itself by the gradual setting of the thin layers of cement in the cracks, and the forcing in of additional cement at low pressure on successive days. Often oatmeal, bran, or dry sawdust is forced in with the cement and settling in the water seals the cracks. If the cracks in the bottom of the shaft cannot be sealed in this manner, it is necessary to put a concrete mattress over the shaft bottom to provide resistance. This

scheme, while expensive, has always been successful.

The Grout Mixing Tank.—The grout is usually mixed by compressed air in a grouting tank, as in Fig. 1, and forced into the crevices by turning the pressure of air in at the top of the tank; or the grout may be forced into the crevices by a pump, with equally good results. The scheme of grouting in rock in the shaft bottom is shown in Fig. 2.

The pressure used in grouting varies greatly according to conditions. If you are grouting in solid rock, the higher the pressure the more efficient will be the grouting. Usually with a grout tank you will use up to 125 lbs. pressure. If you are using a pump, the pressure available is limited, of course, by the steam pressure and the ratio of the cylinders on the pump. In several cases on the Catskill aqueduct grouting was done under pressures as high as 500 lbs., and my recollection is that in one or two cases a pressure of 600 lbs. was used through the use of special equipment. Little high pressure work is done in this section.

Grouting Behind a Shaft Lining.—In grouting behind a shaft lining special care must be taken to gage the pressure properly, and definite results can never be guaranteed. If the holes to be grouted are in a round shaft, or in round ends of a long shaft, they will, of course, stand more air pressure than in the flat side of a shaft, but it is practically impossible to force grout behind a lining with less than 20 lbs. of air, and the possibilities of breaking a flat lining under even 20 lbs. of air are very great. When grouting behind linings was first started, pans or blisters of tin were usually put against the rock rib where the water ran out when the lining was being poured, and a hole was punched in the tin from which a pipe led to the concrete lining form, and the grout was forced through this pipe. This is still done in many cases, but if it is possible to drive a pipe into the water-bearing crevice and calk the rock seam so that all water will lead into the pipe, a much better grouting job can be done, for higher pressures can be used since there is not the area of lining over which the pressure of the grout can get.

Grouting in Slopes.—Grouting in slopes is a more difficult proposition. Since the strata are usually horizontal, the grout injected into the crevices must travel over a greater area to be effective. In water-bearing country it is wise to keep a test hole ahead pointed downward at a greater angle than the angle of the slope. If water is struck, more holes are drilled and grouted to refusal, but in driving a slope through a horizontal water-

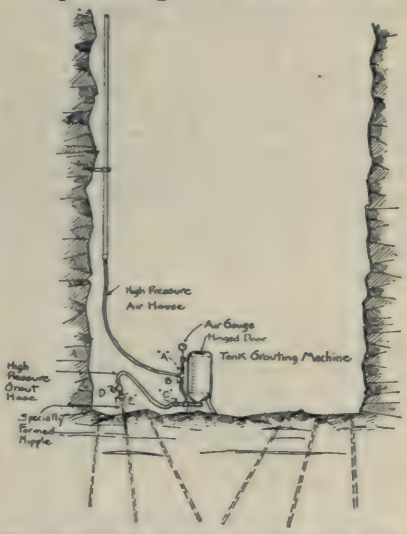


Fig. 2—General Layout for Grouting Operations in Shaft Sinking

bearing crevice it requires a long horizontal distance to get beyond the drainage area of that crevice, so that the sealing of water from a single crevice often requires several grouting operations. Each operation requires not only the time for the injecting of the grout, but a longer time to allow it to set before again shooting the face.

Unloading Sticky Clay From Dump Cars

The peculiar consistency of the material excavated on certain sections of Welland Canal, makes it very difficult to handle. The material is like plastic clay and the steam shovels load on the dump cars great balls of this material about 6 ft. in diameter. At first, states Successful Methods, the contractors used straw to keep this clay from sticking to the bottom of the cars. Then they hit upon better plan—they turned the hose on the slopes where the cars were being dumped. They had also turned water on the sides and bottom of the cars before loading.

Regulation of Overloading of Motor Trucks

Progress Report Presented May 10 at Meeting of National Highway Traffic Association

By D. C. FENNER
Manager, Public Works Department, International Motor Co., New York City

While the last 40 years have witnessed most of the real development in rail transportation what might be considered real development in highway transport has only just begun and in the future we will probably look back upon the years of 1922-1923, as marking the start of a development of the proper basis for the regulation of weights and loads for motor trucks.

In January 1923 the Motor Truck Division of the National Automobile Chamber of Commerce, in cooperation with the Society of Automotive Engineers and at the request of Motor Vehicle Administrators adopted a revised "Standard Caution Plate for Motor Trucks."

The new plate provides space for all the weights needed for purposes of rating, classification, licensing, operation and regulation of the motor truck; for the promotion of safety, the enforcement of law and the protection of the highway.

All these weights can and will be furnished by the manufacturer at the time he attaches one of these plates to each individual chassis and before the chassis leaves his factory. This means that nothing is left to the judgment, the discretion or the inclination of the vendor, the vendee, the operator or even the Enforcement Officer. Information necessary to settle any dispute comes from the maker, attached permanently to each individual chassis.

Enforcement of State Motor Vehicle Laws.—During 1922-1923 many states have strictly enforced their motor vehicle laws. Due to the fact that a large proportion of the trucks in operation had been "underrated but oversold" many operators, fearful of competition, applied for and in most cases received a rerating of their vehicles. In the main this rerating has been handled in a conservative manner and on an intelligent basis by both officials and manufacturers. It was probably the best solution of the difficulties developed by a stricter interpretation and a more rigid enforcement of the law. It should be regarded as a temporary expedient, the need for which will pass as trucks on which the old form of caution plate was used, go out of service.

Many state laws use the term "Manufacturers Rated Capacity." Much of the present misunderstanding is due to the fact that manufacturers once assumed that this would be determined and stamped on the plate by the vendee before he made application for a license. Space was provided on the old form of plate for recording it, but under two headings "Standard" and "Actual." Under the heading of "Standard" the manufacturer stamped his standard tonnage rating of pay load capacity, the basis on which motor trucks have always been rated and sold. The corresponding space in the column headed "Actual" was left blank by the manufacturer. No one could tell what the "actual" carrying capacity might be until the complete truck with body and equipment mounted had been weighed and the "actual tare" deducted from the "standard gross." The manufacturers assumption was rarely justified.

"Manufacturer's Rated Capacity."—Very few pendees paid any attention to the old form of caution plate. They loaded on a big body and plenty of equipment and then made out their application on the basis of manufacturers "Standard rated capacity." For a long time the state sold licenses on this basis. The only attempt which the state made to check up matters was to secure from the manufacturer the relation between chassis number and standard tonnage rating. Then some states started to enforce their law and limit loads to "manufacturers rated capacity" and they discovered that if they added the actual tare weight of the average truck light to the manufacturers "standard pay load capacity" the result, in most cases, was in excess of the manufacturer's "standard gross weight." Due to the failure of the manufacturer, the vendor and the state to insist that the vendee should use the old form of plate in the manner laid out by the

manufacturer, the average motor truck when loaded to the manufacturer's "standard pay load capacity" is actually overloaded to the extent that the actual weight of body and equipment exceeds the manufacturers "standard body weight allowance."

The New Plate.—In the new plate the weight of the load is purposely lumped with the weight of the body and the weight of the equipment. The manufacturer if he so desires may place the size or tonnage rating in the center section but you will not find any direct reference to "manufacturers rated capacity" or "pay load capacity" in the right hand weight section.

We believe that the use of this new plate will discourage under-rating and that it will prevent over-selling. Its use is not compulsory. Manufacturers have suggested that state motor vehicle commissioners should refuse a state motor vehicle license for any truck which is not equipped with a manufacturers caution plate on which all the weights called for are not properly stamped. Irrespective of whether a truck is equipped with an old or a new form of plate we believe that the National Highway Traffic Association should support this suggestion, and further that we should urge the adoption and use of the new plate at an early date.

We further urge:

1. The restriction of loads per inch width of tire, per wheel and per axle.

2. Recognition of the type, condition and factor of resiliency of tire equipment, taken at the time vehicle is weighed, for use in regulating speeds and the determination of license fees according to wheel load.

3. The restriction of the minimum thickness of solid and cushion tires when measured between the tire flange and a flat metal surface on which the wheel stands.

4. The recognition of the tractor and semi-trailer as separate units so that we may encourage the distribution of the very heavy loads over more than four wheels.

5. Rigid enforcement of the provisions of the Proposed Uniform Vehicle Law and existing state laws.

6. Active cooperation in every movement to properly regulate loads and speeds of motor trucks on the highway.

Wonder Mixer with Fuller & Johnson Engine

The Construction Machinery Company of Waterloo, Iowa, manufacturers of WONDER Mixers, recently announced the adoption of engines made by Fuller & Johnson Manufacturing Co. of Madison, Wis., as power plant on all models and sizes of Wonder equipment.

The sizes of Wonder Mixers range in capacities from 3 cu. ft. up to and including 7 cu. ft. of mixed concrete to each batch. Wonder "4", "5" and "7" cu. ft. sizes are furnished either with or without loaders and water tanks, and the Wonder "3" and "4" cu. ft. sizes without loaders are equipped with either road trucks or pneumatic tired steel roller bearing wheels.

Skip Bonding With Electric Bonding Machine

By H. K. FERRELL

Asst. Elec. Engineer, Kansas City, Clay County & St. Joe Railway

From "Traction" Junior for July

After a period of years on any electric railway, bad bonds will begin to show up, due to the usual wear and tear on the track and to the action of the elements. Generally the worst spots are to be found at sidings and public road crossings, many of which, on the K. C. C. C. & St. Joe Ry., are a mile or more apart.

To take care of this work with a bonding machine attached to an extra train or with a bonding machine pushed from place to place by a special crew is both expensive and inefficient.

A simple way out of this difficulty was found in the use of a Lincoln bonding machine mounted on a light push car, made from discarded motor car wheels and axles and weighing but 570 lbs.

Using a motor car to move the bonder from place to place it is possible to stop, repair or renew a bond and be on the way again with this outfit in from three to five minutes' time. This insures that bond maintenance is always kept up and does not in the least interfere with the regular train schedule.

U. S. Civil Service Examination

The United States Civil Service Commission announces the following open competitive examinations:

Superintendent of Construction.—Receipt of applications will close September 25. The examination is to fill vacancies in the Central Office of the Veterans Bureau, Washington, D. C., at entrance salaries ranging from $3,000 to $3,600 a year, and vacancies in positions requiring similar qualifications.

The duties consist of complete charge of labor, materials, and construction on such building projects as are undertaken by the Bureau; the estimation on such building projects as are undertaken by the Bureau; the estimation of labor and materials required, their efficient distribution, and the maintenance of complete and accurate accounts thereof.

Competitors will not be required to report for examination at any place, but will be rated on their education, experience and fitness, on a scale of 100, such ratings being based upon competitors' sworn statements in their applications and upon corroborative evidence.

Computer.—The examination will be held throughout the country on October 4 and 5. It is to fill vacancies in the Coast and Geodetic Survey, for duty in Washington, D. C., at an entrance salary of $1,400 a year, plus the increase of $20 a month; for duty in the Manila, P. I., office at an entrance salary of $2,000 a year, plus the increase of $20 a month; and for duty in computing the triangulation of the Hawaiian Islands, at an entrance salary of $1,860 a year.

The work of a computer in the Coast and Geodetic Survey is technical in character. It involves the computation and adjustment of the data obtained from the field work in one or more of the various branches of geodesy, terrestrial magnetism, tides and currents, and the preparation of the results for publication.

Competitors will be rated on the subjects of mathematics, astronomy, physics, surveying, practical computations, and foreign language (French, Italian, Spanish, or German).

Apprentice Draftsman.—The receipt of applications will close October 2. The examination is to fill vacancies in the office of the Chief of Ordnance, War Department, at an entrance salary of $600 a year, plus the increase of $20 a month granted by Congress, and vacancies in positions requiring similar qualifications.

Applicants must show that they have had training and actual experience in mechanical drafting, obtained either in the drafting room of a manufacturing establishment or a Government establishment, in the drafting classes of day or night schools, or in drafting courses of correspondence schools.

Competitors will not be required to report for examination at any place, but will be rated on their education, training and experience, and practical tests to be submitted with the application.

Assistant Examiner.—The examination will be held throughout the country on October 4, 5, and 6. It is to fill vacancies in the Patent Office at an entrance salary of $1,500 a year, plus the increase of $20 a month granted by Congress.

Applicants must select one of the following optional subjects: Chemical engineering, civil engineering, electrical engineering, electrochemistry, general chemistry, mechanical engineering.

Competitors will be rated on the subjects of physics, mechanical drawings, technics, mathemetics, langauge (French and German), and the optional subject chosen.

Junior Engineer and Deck Officer.—Applications will be rated as received until December 28. The examination is to fill vacancies in the Coast and Geodetic Survey, at an entrance salary of $2,000 a year, and vacancies in positions requiring similar qualifications.

Applicants must have completed at least three and one-half years of a course in civil engineering leading to the degree of C. E. or B. S. in civil engineering in a college or technical school of recognized standing, but graduation with one of these degrees will be required before appointment.

Full information and application blanks for these examinations may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the board of U. S. civil service examiners at the post office or customhouse in any city.

Roads and Streets

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MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.
221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*
LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 904 Longacre Bldg., 42d St. and Broadway
RICHARD E. BROWN, *Eastern Manager*

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Vol. LX. CHICAGO, ILL., SEPTEMBER 5, 1923 No. 3

Education and Punishment for Reckless Drivers

Reckless driving is so conspicuous, and in the aggregate so disastrous, that the offense brings a measure of odium upon the whole tribe of motorists. That this is undeserved by the great majority is indicated by the statement from Pennsylvania Railroad representatives quoted elsewhere in this issue to the effect that reasonable caution was exercised by 97 per cent of the auto drivers observed crossing tracks. But while it is probable that the percentage exercising caution is greater at railroad crossings than elsewhere, the figures furnish good reason for a belief that recklessness at any time is limited to a comparatively small minority.

The problem is how to protect the public from the reckless few, and to a lesser extent, how to protect the few from their own foolhardiness. The "Cross Crossings Cautiously" campaign of the railroads has been carried on with most commendable energy and presumably with worth while results. It can scarcely have escaped anyone's notice, and it is not conceivable in any event that a considerable number of drivers fail to realize that there is danger at crossings. Yet the reckless 3 per cent remains, and in the aggregate numbers scores of thousands.

It is unnecessary here to attempt a psychological analysis showing why persons who know the danger so often act as if they did not know it, but one consideration in such an analysis must be taken: man is prone to gamble when the odds are in his favor. True, he "gambles" of necessity every day of his life, but there are certain activities which more often than others lead men to overrate their odds, and automobile driving is one of them. Education may be counted upon to help but not to cure this condition, and as in so many phases of our complex life we must look to a variety of means to accomplish the desired end.

Active enforcement of a stiff legal penalty seems likely to remain the most practical curb on general recklessness. Without it there is the inevitable tendency to trust to skill and

good luck where the trust is not warranted; but a knowledge that the traffic force means business is a different matter. Then the game is changed by a side bet with odds against the driver. He may be just as confident as ever that he will have no accident but he cannot escape the prospect of a session with the Judge.

Not long ago there was a marked stiffening of enforcement of traffic laws in Chicago followed very shortly by a period of four days in which not one death by automobile occurred. The record since then has not been so good but still it shows an improvement over that which preceded it. Jail sentences and heavy fines are being handed out quite liberally even in cases where no damage has resulted from the recklessness. Intoxicated drivers in particular have drawn the wrath of the Law, and the prospect is good for a marked increase in safety from auto accidents.

The work of the motor clubs in this campaign must by no means be overlooked. Not only have they most vehemently and constantly urged careful operation upon their drivers but they have lent active assistance in the apprehension and prosecution of offenders.

Auto fools, and auto criminals cannot be wholly eliminated, but many fools can be taught and criminals freightened. Enforcement of sensible (not needlessly restrictive) laws, and continuous educational work by all proper agencies must be depended upon to make our roads and streets safer for all who use them.

To Mark Historical Points.—The Pennsylvania Department of Highways is completing plans for the erection of permanent markers at all important historical points along State Highways in Pennsylvania. At this time few such places are indicated by markers. The Department is also planning to erect signs at each stream over ten feet wide so that passersby will know the name of streams. Standard markers are now being prepared for the named highways in Pennsylvania. These in addition to the trans-state name of the thoroughfare will give the through-route number and the local name of the road.

Sound Road Policies

Editorial in The Canadian Engineer.

Food for much thought was contained in the address of M. A. Lyons, chief engineer of the Good Roads Board of Manitoba, at the general professional meeting of the Engineering Institute of Canada in Winnipeg. While local improvements are carried out in a large measure by those who live near by, highways must be constructed and maintained to serve those persons who make use of them whether they come near or far. Policies must, therefore, of necessity be county, provincial or perhaps Dominion-wide. The adoption of a program, then, is a matter for the people of the large rather than the small, community.

Convincing demonstration of the importance of highway problems from the economic point of view was presented by Mr. Lyons in comparative figures of railway and highway traffic in Canada. For example, he pointed out that the cost of hauling freight on highways in Canada was for 1919 about 54 per cent of what was spent for freight on the railways, whereas the cost of moving passengers on roads was about 142 per cent greater than the cost of moving passengers on railways. When the enormous past expenditures, and those to which we are committed, on railways are considered, and the relative importance of highway to railway traffic is remembered, some idea is gained of the support which might reasonably be asked for highway construction. There is danger in the severe effort which Canada is putting forth at the present time to solve the railway muddle that the tremendous importance of primary transport may be forgotten. If such should unfortunately be the case, it will be found to have reacted prejudically on the railway problem itself. Only by providing and maintaining first-class highways throughout the country would it be possible to feed and support the railways to the extent necessary if they are ever to be placed on a paying basis.

Pennsylvania Mileage Completed in 1923.—Up to Aug. 19 the Department of Highways had completed 150 mi. of durable highway during the 1923 construction season. There are now approximately 140 construction jobs in progress.

Grade Separation at Railway and Highway Crossings

Dangers Overcome, Joint Obligations and Benefits, Types, Designs, and Other Considerations as Treated in the Concrete Highway Magazine for August

Each morning as we read newspaper reports of the preceding day's crossing accidents the dangers at these points become more and more evident. In one case the driver thought be could beat the limited to the crossing. In another the gates were not closed. In a third it was the brakes on the car that were at fault. At still another point no special warning or protecting measures had been installed as it was considered a safe crossing, the view being clear in each direction. Careful drivers will not start across railroad tracks until they are sure there is no danger, but even careful drivers are sometimes negligent.

Whatever may be the reason—or lack of reason—the fact remains that crossing accidents not only continue but are ever increasing in frequency. After two or three accidents at a crossing, agitation is started for its elimination. Or one particularly horrible accident may arouse public opinion and start action.

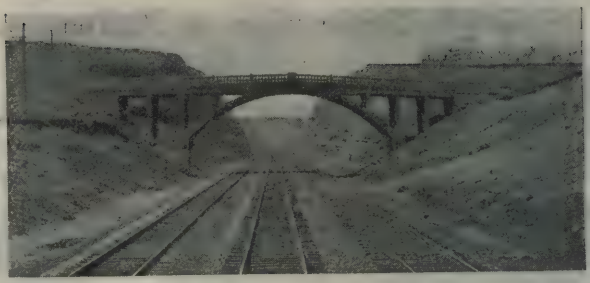
In many cases progress is seriously hindered by failure of one or both parties to give reasonable consideration to the other side of the argument on division of cost. Ordinarily inability to reach an agreement means long legal proceedings before the Utility or other Commission empowered to act in such matters. The questions of life and property are so important that unnecessary delay is inexcusable and all parties should co-operate to expedite elimination of the crossing.

The public benefits greatly from grade separations through elimination

Creditable Crossing of Naturally Separated Grades on the Line of Pittsburgh and Shawmut R. R. near Colwell, Pa.

of delays at blocked crossings and in greater safety. It should be willing to pay for those benefits. The railroad benefits through elimination of liability for damages, maintenance of crossings, and operation of gates or watchmen. Probable reductions in maintenance and operating costs are easily determined and these savings, capitalized are often sufficient to pay for the large part of the railroad's share of the cost. At the same time the saving in delays to the public will usually return a large part of the public's share of the cost. Thus the net cost of the added safety and convenience is relatively small.

Other questions



A Safe Crossing That Was Dangerous on Scranton Division of Delaware, Lackawanna and Western.

Delaware, Lackawanna and Western Crossing at Morris, N. J., Showing Street Realignment to Improve View Ahead.

Delaware, Lackawanna and Western at Montclair, N. J.

Erie R. R. Crossing at Kenmore, N. Y.

penses. In other cases raising the tracks may be equally objectionable. For that reason the railroad is usually allowed to choose between an over and an under crossing. On the other hand, if either party insists upon one type of crossing in a case where the other would be less expensive, it should be willing to bear the

New York Central Viaduct at Tonowanda, N. Y.

involved in grade separation are fully as important as the division of cost. The railroad must consider its operating efficiency. It cannot agree to lower its tracks where the resulting grades would be excessive, causing delays to traffic, limiting the length of trains, and increasing operating ex-

New York Central Track Elevation, Kenmore, N. Y.

greater portion of any excess cost.

Many underpasses have been built at right angles to the railroad regardless of the direction of the highway in order to reduce the size of structure required and save expense. Where such construction places "kinks" in the highway, the view is apt to be obscured and new hazards introduced, which in some cases may make the underpass more dangerous than the grade crossing it replaced. To avoid such new hazards every effort should be made to give the motorist a clear view, even if it is necessary to build the subway at an acute angle or to relocate the highway.

A Pennsylvania Grade Separation.

Occasionally this situation occurs at an overhead crossing, but such cases are less common.

Where conditions are such that it is decided to carry the highway over the railroad the desirability of concrete construction is especially evident. Concrete cannot catch fire from sparks or cinders blown out with the exhaust, nor is good concrete affected by locomotive gases or blast. Ordinarily the clearance between the top of rail and an overhead bridge is around 22 ft. But in the yards of the Chicago and Western Indiana Railroad in Chicago there is a bridge with only 17½-ft. clearance. After being exposed to the blasts of the heaviest locomotive traffic for seven years the concrete on that bridge is in excellent shape, the form marks still being plainly visible.

For spans up to 30 ft. reinforced concrete slabs are ordinarily used. For longer spans, reinforced concrete girders carrying short floor slabs are usually more economical. Where clearances are sufficient deck girders are usually favored, not only on account of greater economy but also because they permit a more attractive design. Where clearances are ample and foundations good a concrete arch is often used, the attractive appearance of a well proportioned arch frequently influencing a decision in its favor. Because of this factor, a facing is sometimes applied to a slab or girder to give an arch effect.

The same principles are true where the railroad crosses over the highway. In that case less clearance is necessary, fourteen feet being a common requirement, but the loads carried by the structure are heavier. Very attractive structures have been designed in many instances. Precast concrete slabs are often used in order to minimize interference with normal railroad operation during construction. Some highway authorities object to putting a pier in the center of the highway while others not only do not object, but actually prefer such a pier as tending to separate traffic and prevent accidents.

Although thousands of grade crossings have been eliminated in the last decade, grade separation is still in its infancy. One prominent railroad estimates that grade separation work that will probably be required on its lines in the next twenty years will necessitate an expenditure larger than that railroad's present capitalization. All grade crossings can not be eliminated at once, of course, but the indications are that progress on this work will be rapid in the next few years.

Lincoln Highway Improvements Including Five Grade Crossing Eliminations in Iowa

Crawford County with the aid of the Iowa State Highway Commission plans to straighten out ten miles of the Lincoln Highway between here and Dow City, eliminating three double track crossings of the Chicago and Northwestern Railroad and two single track crossings of the Illinois Central.

At present the Lincoln Highway runs north of the Chicago and Northwestern and the proposed plan calls for a new right-of-way, to be ultimately paved, following a practically straight line along the foothills. This alignment will also do away with many right angle turns and approximately a mile and a half will be eliminated from the distance.

Concrete Single Track Highways

Experiences of Brant County, Ontario, in Construction of 9 ft. Concrete and 9 ft. Gravel Roads Described in Paper Presented June 12 at Annual Convention of Canadian Good Roads Association

By A. M. JACKSON,
Engineer, Brant County, Ontario.

Single track roads are, in the writer's opinion, a financial expedient. Nobody would build a hard surfaced road wide enough for one vehicle only at a time, if they could afford to build it wide enough for two. A single track road, however, will go twice the distance a double track will go for the same money, and the question resolves itself into this: will you have twice the length and half the width, or twice the width and half the length?

These statements are not absolutely precise, but I have found that a 9-ft. concrete slab laid on one side of the centre line of a road, with a 9-ft. gravel track on the other side of the centre line costs from 57 to 60 per cent of the price of an 18-ft. slab. This comparison is made on the basis of the turnpike required by the Ontario Department of Highways for a provincial county road, viz., 28 ft. from shoulder to shoulder.

It will readily be seen that the actual grading and ditching for both types would be the same, that the water supply for mixing and curing the concrete would be the same for both types, that the cost of actual laying would be slightly greater in the case of the narrow type on account of the increased amount of moving of the plant and forms, and finally, the principal reason why the one type costs more than one-half of the other is the addition of a gravel track beside the concrete.

Truck Loaded with One Batch in Each of 5 Compartments Discharging a Compartment Into Mixer on Construction of Single Concrete Track.

Half Width Concrete Roads.—The Brantford Suburban Area Commission was on the principle of pay-as-you-go in 1920 in the position of having just sufficient money to maintain their roads and to build one mile of 18-ft. concrete road each year. Their two heaviest travelled roads were the two main market roads with a subsequent area of 4 miles on each; eight miles of

full-width concrete road would mean that it would be eight years before the last rate-payers were served. The Commission decided to build half-width concrete and to place the slab on one side of the centre line. Two miles were built in 1921 and two miles in 1922 and the other half of the roadway constructed of crushed, pit-run gravel. The experiment appears to have justified itself and at the end of four years instead of eight, the rate-payers on both these roads will have an every-day-in-the-year road to their market town.

Preparation of Subgrade.—Standard practice in the laying of concrete roads has undergone marked improvement and change since 1917, and it

Gravel Overlapping and Protecting Edge of Slab.

seems unnecessary that I should dwell on this phase of the subject. However, it would appear to me that a number of the failures in concrete pavements have been partly due to the want of uniformity in the sub-grade. I feel that in so severe a climate as we have, the sub-grade for a payment should always be prepared a year ahead of the actual concrete laying.

The prepared sub-grade should conform as nearly as possible to the contour that will be adopted under the pavement. For an 18-ft. slab this would be flat, while for a half-width slab on one side it might have a fall of 2 in. towards the ditch. The proper banking on curves should be provided in the sub-grade at the same time so that the whole will settle uniformly.

The sub-grade should be coated with gravel or stone and a fall, winter and spring allowed to pass before any concrete is laid. This coating of 6 in. of gravel or stone should be strengthened where weaknesses have shown and would provide a uniformity of sub-grade not usually obtained when the work is done immediately in advance of the mixer. This coating will not only serve the traffic over the prepared sub-grade, but will tend to reduce the condensation and accumulation of water under the concrete which is a prolific cause of heaving, uneven settlement and cracks.

Construction of Concrete Section.—On four miles of concrete pavement laid by the Brantford Suburban Area Commission in 1921 and 1922, on one side of the centre line, the sub-grade was prepared as stated. The slab was 7 in. thick throughout and was tilted 2 in. One edge was laid on the centre line of the turnpike and 9 ft. of pit-run crushed gravel was laid alongside in two layers and consolidated by traffic. The concrete was 1:1½:3½ using 2 in. to ⅜ in. crushed stone and a grade of coarse sand which proved satisfactory under the standard color test with sodium-hydroxide.

The stone was hauled to a central stock pile in the winter and a central proportioning plant was established at this point. Measured batches of stone and sand were hauled by trucks divided into separate compartments to the mixer, the trucks backing down between the side-forms set 9 ft. apart to receive the concrete. At the mixer the trucks were up-ended as for dumping, and one batch at a time was shot into the hopper of the mixer where two bags of cement were added. Owing to the sub-grade having been prepared the previous year, and simply skimmed to true contour ahead of the mixer, the trucks seldom made any impression on the sub-grade; when they did, soft material was removed and crushed gravel added and rolled.

This test of the sub-grade has the obvious advantage of showing up weak spots before they are coated and finally put out of sight to cause subsequent cracks and settlement. Mixing was for 1 to 1½ minutes in the drum after water had been added by an automatic measuring device and placing was by boom and bucket. Hand tamping was used and this heavy work as well as the finishing was found easier to do well on the narrow pavement, than it is on an 18-ft. slab.

Water was supplied from a 2-in. pipe line and pumped from a creek by a triplex pump with a booster pump one and a half miles up the line. The water had to be pumped an extreme distance of 3½ miles.

An average of about 400 lin. ft. laid per day was obtained, with big days

of from 600 to 650 ft.; ⅜-in. elastite joints were placed every 40 ft. in 1921, and 50 ft. in 1922 and also at stoppages. The green concrete was covered for a day with canvas on frames and then coated with earth and wetted continuously for three weeks. The slump test was used and up to a 2 in. slump allowed. This has resulted in a pavement without any longitudinal cracks.

There are 46 transverse cracks in 4 miles, including one diagonal corner crack. Many of these are hair cracks and not open sufficiently to be repaired with tar. In several cases two cracks have occurred in the one slab and they have invariably occurred a little below the summit on rises. No increase in number seems to be due to the extra length of slab adopted latterly, and the entire absence of longitudinal cracks due to the half-width type is very satisfactory.

All curves were banked, but in the first season's work where the slab was on the outer side of a curve, no widening was used because it was figured the widening would be added on the inner side of the second slab when the road was double tracked. This was a mistake which had to be remedied the second season. Widening of the curves on a single track road is even more necessary than on a double track, and should, I think, be proportionately somewhat more. The standard allowance of ½ in. per ft. for banking on curves of 300 ft. radius was used and this I consider should be increased where the curve is also on a grade, otherwise the destructive action of side-slipping is liable to become evident and with insufficient widening would call for heavy maintenance of the gravel at the edge of the slab.

No Rutting Has Developed.—Criticism of the method of having one-half of the surface of gravel and the other of concrete has been that there would be a rut formed at the centre of the road along the edge of the slab. Up to date this has not been the case, but banking and widening on curves should be carefully provided for or such ruts would form.

The gravel part of the surface has been kept dragged smooth and well up to the concrete, our endeavor having been to keep the gravel slightly overlapping the edge of the slab. Extra material has been added to the gravel when it has become consolidated below the slab and the ready adherence of new material in very thin layers to the existing gravel road is one point which, I think, makes this type of construction more suitable in gravel counties than in those where only macadam is used.

The cost of dragging on this road has been approximately one-fifth of what it was when the whole surface was gravelled, and I estimate that with a vehicular traffic of something over 500 per day during the summer, that 90 per cent of the travel is on the slab.

No Traffic Accidents Due to Method of Construction.—There have been several accidents on this road since it was paved but none due to the method of paving on one side of the centre

Curve on Grade Superelevated 9 Inches.

line, which has the effect of so clearly showing where the middle of the road is that there can be no mistake made about it by the most inexperienced driver. The side of the road paved was that going out of town because changes in the alignment of the old grade gave heavy fills on the other side. I think there is probably argument in favor of the pavement being laid on the in-to-town side, though the gravel road can be kept so smooth that some vehicles will keep on it entirely rather than bother to run on the slab and turn out when overtaken. There is no perceptible jar in turning on or off the concrete. Notice boards stating that west bound traffic has right-of-way on the concrete were set at conspicuous points on the road and have apparently served their purpose, as no difficulty has been experienced with person not observing the rules of the road.

Main market roads as a rule are those constructed by the county and to finance the full pavement of all a county's main market roads would be a burden greater than any county

could bear unless it were assisted to an unusual degree by contributions from the state and urban areas. The great majority of main market roads in this province would undoubtedly fall into the class with a vehicular traffic of up to 500 per day, while a small percentage would come in the class of 500 to 1,000 vehicles per day, and it seems doubtful if any road carrying more than 1,000 vehicles still belong to a county system as such have ere now been assumed by the province as provincial highways. At the same time there must come a period on almost all main market roads when the matter of a hard top has to be considered, and it seems that to build only full-width pavement would mean leaving out of the program a very large proportion of the main market roads because of the great cost of such paving.

The question of finance must then bring up the desirability for some expedient where traffic reaches 500 vehicles per day and this seems to me to be met satisfactorily by a half-width strip of concrete laid beside a strip of the same width of gravel. It must always be borne in mind that the people can only have that type of road for which they can afford to pay. When it becomes economical to provide a single track of hard surface, I believe the logical place to put that single track is with one edge on the centre line of the road and not in the centre of the turnpike. There are several reasons for this opinion; the other half of the road surface can be more easily and effectively constructed than where the hard surface is in the centre and the balance has to be made up of two narrow strips, one on each side. The duplication of the hard surface can be more easily and economically constructed in one wide strip than in two narrow ones, only one longitudinal joint is formed when traffic warrants the widening of the hard surface and this, in the centre, forms a good division line for traffic. With the edge of the hard surface on the centre line on whom the onus of turning out falls, can not be a matter of dispute.

Construction and Maintenance Costs.—Regarding costs, I would say that these are bound to vary tremendously in different localities, so that the figures which I give are more for comparison than to be taken as the actual cost today of the different types. From data I have been able to obtain and check from my own experience, an approximation of construction and maintenance costs on such a comparative basis is as follows:

Table I

Type	Cost to build per mile	Maint. up to 500 vehicles per day	Maint. up to 1000 vehicles per day	Maint. up to 1500 vehicles per day
18 ft. concrete	$40,000	$100	$200	$300
9 ft. concrete and 9 ft. gravel	23,000	200	400	1,600
18 ft. gravel	6,000	1,000	2,000	4,000

To retire the cost of a concrete pavement 18 ft. wide in 15 years at 5½ per cent per annum will require an annual payment of approximately 10 per cent of the principal sum or $4,000, and with $100 per mile for maintenance would represent an annual cost of $4,100. Treating the cost of a half and half gravel and concrete road in the same manner would represent an annual cost of $2,500, and similarly for a gravel road an annual cost of $1,600. Now taking the case of roads with a vehicular traffic up to 1,000 per day, these three costs would become—for concrete $4,200, for gravel and concrete $2,700, and for plain gravel $2,600.

From a study of the foregoing, it will be seen that where gravel is used for one track and concrete for the other, with the traffic from 500 to 1,000 vehicles per day, the half and half type of road will be more economical than a full-width concrete pavement and preferable to a full-width gravel road in that the cost per mile over a period of 15 years is almost the same, but the advantage of a hard surface on part of the width would far out-measure any such small difference in cost as $100 per mile.

The type of construction which I have been describing would appear more suitable in what I would call a gravel and concrete county than in one in which no gravel is to be found, and where all roads must be constructed by some of the various combinations of crushed stone and bitumen.

I have not had the experience of constructing macadam on one-half of the road surface with concrete on the other. On account, however, of the tremendous destruction caused by

motor trucks during the war of the finest macadam roads to be found anywhere, I refer to the roads in Scotland, where Macadam was born, the Transportation Commission for Great Britain advocated 2-ft. concrete wheel tracks in the existing macadam roads, so that it was obviously considered that this form of construction was quite feasible.

Let me say, however, to those building roads in counties where no gravel exists but only stone, that I have built in some gravel road stretches composed of pit-run crushed stone with all stone over 1 in. removed.

These stretches were laid and treated in exactly the same manner as the adjacent stretches of crushed gravel and under a heavy traffic of narrow tired overloaded Ford trucks running to a milk factory have stood up satisfactorily and like a gravel road can be dragged and kept smooth throughout their life. When such roads are worn down to half their original thickness they still have this advantage over macadam, that they can always be kept as smooth as when newly constructed, by the simple process of dragging.

Business Conditions and Prospects as Seen by the Guaranty Trust Co.

Despite the strength of restraining influences upon trade, both domestic and foreign, including the customary seasonal factors tending to lessen activity, there has been only a moderate curtailment recently in production and distribution in the United States, according to "The Guaranty Survey," published on August 27, by the Guaranty Trust Company of New York.

"It is evident," the "Survey" continues, "from a general view of domestic production and distribution that the volume of current business remains large when measured by any other than peak standards. The decline in prices and recession in the volume of business are not accompanied by the usual initial characteristics of a major depression. Inventories are generally conservative, bank credit is not over-extended, and interest rates remain moderate. Instead of the over-expansion of construction which has usually preceded drastic and prolonged depression, there remains a general shortage of housing and other construction. The reaction both in security and commodity markets from the levels of the early months of the year has prepared the way for more nearly stable and normal business. And the fall seasonal stimulus may be expected to quicken the pace of industry and trade. The railroads have prepared for the movement of an unprecedented volume of freight. Altogether, there are conditions favorable to a continuation of good business.

"On the other hand, the sharp decline in prices both in security and commodity markets, accompanied by a reduction in forward buying, has somewhat weakened general confidence.

"A fundamental difficulty confronting American business is the depressed condition of the export trade. The volume of exports—allowance being made for price changes—is runing far below what may be considered normal and has been less this summer than last, although the absolute values differ only slightly. The volume of imports, however, reached an unprecedented level in March, followed by a considerable decline with the relaxation of demand for foreign raw materials. Preliminary figures show an excess of exports in July to the value of $26,000,000, the first monthly export balance since February.

County Superintendents of Road Maintenance in Pennsylvania Classified.—The Pennsylvania State Department of Highways has adopted a classification scheme for county superintendents of road maintenance. The Department has established three classes of maintenance superintendents. Class "A" positions carry a salary of $225 per month and head those districts which spend from $200,000 to $500,000 per year. Class "B" superintendents are those whose districts spend from $100,000 to $200,000 per year, and the salary is $200 per month. Class "C" positions, in those districts which spend less than $100,000 per year, have a salary of $175 per month.

Culverts and Small Bridges

Abstract of Paper Presented June 13 at Annual Convention of Canadian Good Roads Association

By E. L. MILES,
County Road Superintendent, Lindsay, Ont.

Water is by far the greatest enemy to road builders in the province of Ontario, owing to the fact that our winters are severe, the spring run-off rapid, and our summer storms heavy. No matter how well the surface of the road is constructed for the traffic it is expected to serve, if water is allowed to accumulate and soak into the road, or to run over it, the surface is bound to be injured by heavings, washings or softenings.

Three Points to Watch.—With this knowledge at hand, there are at least three essential points to watch:

(1) That the spring run off and summer storms shall be allowed to pass freely through culverts.

(2) That the surface of the road should be well above the capillary attraction from ordinary water level in the ditches in the fall of the year.

(3) That the drainage from the surface of the road should be to the ditches and not allowed to stand and soak back into it.

Of these three points, the first is probably the most important. Many land owners, and a few road builders consider that the road ditches should be used as drainage canals, carrying water for long distances to definite outlets or bridges. The result is that snow and ice blockade cause the water to dam up and run over the surface as well as to soak into it. Efficient road drainage is an essential to road building as land drainage is to agriculture, and the water must be allowed to pass from one side of the road to the other as quickly and as often as possible, and thence away from the road altogether in original and natural course.

Sizes Pipe Culverts.—It is economy to place culverts in all runways, notwithstanding the fact that they may operate but once a year, and it is wise to adopt a policy of minimum size in order that their operation may be assured, and not always subject to ice and snow, or grass and weed blockades.

There is but little value in an 8 or 10-in. pipe culvert either across the road or at farm crossings in the ditches. 12-in. pipes might be used in ditches near the summit of the watershed, but 15 in. should be the minimum for ordinary cases. The minimum across the road should be 18 in. and larger sizes used according to the acreage drained, and the slope of the land. The maximum pipe culvert should be 30 in. limited because of the additional area obtained in the box type without extra expense. Headwalls should be constructed on all pipe culverts after the construction of the road, allowing the full standard width of road between them. Careful inspection of all pipe culverts should be made in the fall of the year in order to clear them of grass, weeds, driftwood, etc., and then again in the spring when the run off is taking place.

Of the second point, it might be said that if the road surface can be lifted away from the influence of capillary attraction that there need be no worry from standing water in swamps, or low lands. Three feet above ordinary water level in such cases is usually sufficient.

Of the third point, it might be said that the ruling crown of roads built for fast and frequent traffic will not effectively discharge the water from the clay or gravel shoulders, and therefore the shoulder should be crossed at regular intervals of not less than 50 ft. by stone drains. These drains so constructed as to allow efficient drainage a few inches below the metalled or paved portion of the driveway. The water will then run along the edge of the pavement to the drains and thence to the ditches without soaking under it.

Tests of Gravel in Field.—Gravel is the principal material used for concrete aggregate, and almost every pit is graded differently. To get the greatest efficiency from the gravel as we find it, a few simple field tests should be made as follows: (a) vegetation; (b) silt; (c) coarse aggregate; (d) voids.

Vegetation can be seen by careful examination, or by washing the material in a bottle. Silt can be measured by washing in a bottle and allowing the mixture to settle. It should not be more than 3 per cent. Coarse aggregate should be over one-half of the total material retained on a ¼-in. mesh screen. Voids: The proportion of water that can be poured into a given quantity of gravel will equal the proportion of cement required.

The proper quantity of water is

measured by the slump test. That is, a column of fresh concrete should retain its shape when turned out of a cone and not run or settle down in a shapeless mass. For the foundation work, it should not settle more than 12½ per cent and for reinforced concrete not more than 20.8 per cent.

Tamping and spading is a great factor in securing good concrete, and this should be done as much as possible while it is being deposited in the forms. Not only are all the air bubbles removed, but the concrete surface shows the results when the forms are taken off, and much less rubbing and plastering is required.

In the construction of all beams, floors and head walls, it is considered safe, sane and economical practice to wash the gravel. That is, to run it through the mixer just prior to use, and to pour off the dirty water.

Foundations for Bridges.—With regard to the foundations for small bridges, it is of course essential that a secure bottom shall be found, and in most cases this is not difficult. In swamps, however, where the stream is winding and sluggish, it so happens that encounter considerable depths of muck and soft clay. In these cases, it is not essential to reach the bottom of the muck with the concrete, but instead, a pile foundation can be driven, using a follow block so that the head of the pile will be three or four feet down in the muck. Then by driving wakefield piling to act as forms, the muck can be pumped out to the depth required, and the concrete placed a foot or so below the top of the pile and brought to a point about 6 in. above water level. On top of these foundations the bridge can be constructed without danger of settlement or collapse.

Concrete can be successfully poured under water by using a little care. A very good method is to pipe it through the water, keeping the pipe always filled above the water line and by moving it around on the bottom so as to let the concrete out. After the bottom course of about 8 in. has been placed, the forms can be pumped out and the concrete continued under ordinary conditions.

Reinforcing in concrete culverts and bridges is placed mainly as a strengthener for good concrete but it should also be placed as insurance against poor workmanship, such as in wing walls where no load is to be carried.

In conclusion I would suggest that every concrete structure should bear a date stamp such as "1923" in some conspicuous place along the coping wall. It will be interesting for the future generations to note two features: First—The conditions of the concrete according to its age. Second—The wisdom and foresight of the present day designers. Already we are blasting our narrow concrete culverts that were erected as "permanent" structures 10 years ago. In some cases the concrete is too poor to even use in a foundation for a new structure.

Roadside Trees Protected by Highway Department

Division and District Engineers in the employ of the Pennsylvania Department of Highways have been instructed by the Department heads that they must be zealous in protecting trees on the right of way during construction work. A letter sent to these employes says:

"You will appreciate that it is of the utmost importance that no trees shall be cut down in connection with highway improvement unless it is absolutely necessary. Plan your work in such manner as to take full advantage of shade trees. In working up your construction plans where shade trees of considerable growth can be saved without interfering with proper alignment and with due regard to proper construction, this must be done. There is no excuse whatever for any trees being unnecessarily destroyed or injured during the progress of the work."

The Pennsylvania Department of Highways in co-operation with the State Forestry Department is also undertaking to plant additional trees along sections of the main highways where trees are lacking. It is believed that Pennsylvania is the only state in the Union which to date has used portions of its highway fund to undertake beautifications of the state routes. Ultimately, it is believed that the proper beautification of roadsides will be considered a portion of the cost of main highway improvement. The Lincoln Highway across Pennsylvania is considered by many to be one of the most beautiful drives in the United States and much of its existing beauty is due to the ancient trees which line the route through the Alleghenies.

Road Maintenance in Monroe County, Michigan

Methods, Materials and Organization

By GEORGE E. MARTIN,
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Monroe County, Michigan, lies midway between the cities of Detroit and Toledo, and as a result of this location is confronted with the necessity of caring for a large amount of through traffic across the country in addition to local traffic. This condition has been met by the construction of pavements on the through traffic roads in general, although a twelve-inch water-bound macadam, maintained by surface treatments of refined tar, successfully carries the traffic on one section of the Dixie Highway.

The local roads are practically all built of water-bound macadam and surface treated with refined tar. A total of about 125 mi. of macadam roads is maintained in this manner. The earlier roads were built six inches thick and fourteen feet wide. Present practice in the country is to build water-bound macadam eight inches thick in two four-inch courses and from 14 to 20 ft. wide. Both limestone and slag are used for this work. All turns are constructed with a three-inch penetration top on a water-bound macadam base. A surface treatment with one-half gallon per square yard of tar is included in the specifications. This treatment can not be applied, however, until the road has been under traffic for several months and is perfectly clean. The price per square yard bid on the surface treatment ranges from 12 to 15 cts. per square yard on a treatment taking from one-half to two-thirds gal. per square yard. It is optional with the County whether this work is done by it or by the contractor who built the road.

Loading Slag Into Distributer.

Shortage of labor and rising costs induced the County Highway Commissioners to adopt various labor saving machines for their maintenance work this year. All of the work is done by the County by force account and all of the machinery and apparatus is owned by the County. Maintenance of the water-bound macadam roads involves patching and cleaning of the road and application of the tar and cover. On old roads where only the carpet coat is broken, skin patches are made with Tarvia "B" and slag cover. Deeper holes are repaired with Tarvia

K. P. mix or by making penetration patches with Tarvia X. The patching outfit consists of a truck to haul the mix or stone aggregate and a trailer filled with barrels of the bituminous material. Where hot mate-

Distributing Slag.

rial is used a tar kettle is added to the outfit. Two men do the patching operations.

Dust and dirt are removed from the road ahead of the surface treatment

Blowing Dust Off Road Before Treating.

eration by sweeping and blowing. he sweeper and blower are mounted a truck which works ahead of the distributor.

New roads are given from one-half two-thirds gal. per square yard of d refined tar in two applications. e road is closed to traffic and the st application allowed to soak in about four hours before the second application is made. Cover is d on the last application only. eatment the second year usually consists of one-third gallon per square yard and succeeding years about one-fourth gallon per square yard of cold tar. After the third year it has been found possible to omit one year's treatment in some cases and in a few instances it has been omitted for two years. The condition of the road in the Spring is the determining factor in deciding whether to treat a road that season or not.

Number six air-cooled slag is used for cover on the surface treatments. This material ranges in sizes from one-half inch to one-eighth inch. It is received in cars, unloaded with a clam shell bucket into trucks and hauled to 40-ton stock piles at convenient loading places along the road. A Bangert distributor has been attached to one of the County trucks and is used to spread the cover on the tar treatment. Somewhat less than fifteen pounds of slag per square yard is used for cover.

Five men handle the actual surface treatment operations. One man drives the sweeper and blower which cleans the road. The tar is shipped to convenient points in tank cars and applied with a 750-gal. distributor owned by the County. One man drives the distributor and the foreman operates the rear end of the distributor. Slag is loaded from the stock pile with a portable clam shell bucket mounted on a truck, into the truck fitted with the Bangert distributor. This truck backs over the fresh tar distributing the slag from the rear end. One man operates this truck and the clam shell with the assistance of the fifth man as a helper. This outfit covers about

one and one-half miles of fourteen-foot road in a day.

The successive surface treatments of the older roads has resulted in materially widening them. While this additional shoulder of bituminous material is not very solid, it has been sufficient to carry the traffic which turned out on it and has protected the edges of the original road.

By following a definite maintenance program, Monroe County has been able to build up a mileage of most excellent local roads, which are dustless in the summer and in good usable condition during the entire year at a comparatively low cost.

General plans for financing and carrying on the work are made by the County Highway Commissioners, Messrs. Wm. Heiss, James Vance and John Hayward, while the actual details of the construction and maintenance operations are carried out by Mr. W. S. Cumming, County Highway Engineer.

Crossing Accidents Almost Wholly Due to the Fault of Three Per Cent of the Drivers of Autos

From "The Golden Circle," Journal of the North Shore Motor Club, Chicago

Sponsored by the American Railway association in an effort to cut down accidents at grade crossings, the second annual Careful Crossing campaign now is under way to continue until September 30. Broadcasting the slogan "Cross Crossings Cautiously" to motorists throughout the United States, a large four-colored poster drives home the idea that beating the train across the crossing is a poor way to save time.

Employing every available means of publicity, the Chicago Safety council, in charge of the campaign in Chicago, holds the hope that the efforts this year will be rewarded by a record which will show far fewer crossing deaths than the 758 fatalities recorded during the summer months of 1922.

In addition to its use on the large poster, this impressive design portraying immediate disaster to the reckless motorist and showing how 9,101 persons lost their lives in five years, has been adapted to many other uses. Railroads and other agencies for outgoing mail are using correspondence stickers, and automobile windshields are displaying a miniature of the poster. Publishers of the automobile blue book and road map have agreed to stress the campaig in the publications, and a large nun ber of motion picture houses throug out the country will flash reprodu tions of the poster on their screen

Included in the Safety council's pr gram for Chicago are special instru tion for school childen, distribution thousands of the posters, pamphle and windshield stickers, safety a dresses to be made at the motor dr vers' school on the Municipal pier, ar radio talks via several of the local st tions.

Just where responsibility for th majority of grade crossing acciden lies is forcibly brought out by an a alysis of 384 accidents occurring one year on the Baltimore & Oh railroad. Negligence of railway en ployes was responsible for two acc dents; three were undetermined, ar the remaining 379 were clearly a tributable to the driver of the v hicle.

Vehicles attempting to beat th train over the crossing were respo sible for 183 disasters and the m chine stalling on the track accounte for sixty-eight more. Fifty autom biles crashed through crossing gat into moving trains, with forty mo meeting the same fate at crossing having no such protection. In o instance it is reported that a mot car struck the twenty-seventh car a freight train.

Twelve accidents were caused b defective brakes and twelve more b stopping the car too close to the trac Eight accidents were due to intox cated drivers and six to crossing fro behind one train into the path of a other.

Officials of the Pennsylvania syste report that in observing the condu of 100,000 motorists at grade cro ings it was found that 97 per cent them exercised reasonable care—th remaining three per cent conductin themselves in a manner that in man cases was grossly careless.

Experience shows that practicall all highway crossing accidents can b avoided with the exercise of ordinar care on the part of the driver of th motor vehicle, the Safety council a serts. Even in those cases where th negligence of the railroad employe o viously has been at fault, the disas ter might have been averted had th driver depended on his own eyes an ears than place too much confidenc in the watchfulness of others.

Transfer Company Provides for the Moving of Heavy Equipment

A novelty in service which may be the pioneer of some radical changes in contractors' transportation methods has been introduced by the Douglas Transfer Company of Pittsburgh, Penn. This concern has added to its equipment a new truck trailer especially designed for the hauling of steam shovels, road rollers, concrete mixers, gas engines and transformers. The cut below shows this truck in use.

In the past two years, the excessively heavy traffic on streets and roads in territory in which the Doug-

Steam Shovel Being Moved by Transfer Company.

as company operates has caused a demand for transportation that will eliminate the serious injuries to road surfaces and the traffic blockades incident to the moving of heavy equipment of the types named. The moving of steam shovels under their own power is slow and tedious with many drawbacks, and is hard on the mechanism of the shovel. The new trailer makes it possible to move any type of shovel or road roller in a small part of the time required to move under its own power, and the trailer is so designed that the loading and unloading is very easily accomplished. The resultant increase in working time of equipment needs no comment. Contractors' delays through failure to receive permission of municipal authorities for the removal of their heavy equipment are eliminated by the use of the trailer.

Recently, the Douglas Transfer Company moved an Erie ¾-yd. shovel on its trailer a distance of 11 miles over an extremely hilly section in 3½ hours, actual hauling time. It was necessary to load and unload the shovel three times during this trip on account of overhead bridges, low steam pipes and wires, and other obstructions. The unloading and loading was accomplished, in one instance, in 7 minutes from the time the trailer was stopped until it was ready to move again.

Another job by the same company was the moving of a type B-20 Bucyrus shovel a distance of 12 miles from East Liberty, Pittsburgh, to Dormont, Pa., for the Netherlands Construction Company of Pittsburgh. This was an exceptionally difficult piece of moving, due to adverse weather conditions, overhead obstructions and the steep grades encountered. Some of these grades were as steep as 25 per cent, and the maximum length of grade exceeded 3 miles. This moving was accomplished in 5 hours, 30 minutes, actual hauling time.

Indiana County Commissioners to Meet.—The County Commissioners Association of Indiana, will hold a convention at Evansville, Ind., Sept. 24 to Sept. 27. Arthur C. Stone, Evansville, Ind., is in charge of preliminaries.

Motor Truck Transportation

Address Presented April 30 at Annual Convention of Allied Motor Commerce of Indiana

By H. W. HOWARD,
General Motors Truck Co., Pontiac, Mich.

Transportation by motor truck lies entirely within the 20th century. While the railroads have been building since the fifties and have taken over half a century to acquire their present proportions, the first motor truck was built as late as 1900.

I should like to illustrate by figures relating to 1921, just how freight haulage by motor transport compares with that carried by steam railroads, (1922 figures are not yet complete):

Railroads carried 1,642,251,000 tons of freight.

Motor trucks carried 1,430,000,000 tons or 87 per cent as much as the railroads; truly a remarkable showing.

The Widening Field for Motor Transport.—Someone has well said that "the future development of any type of transportation will be governed by the economic value which it will be able to show the communities it serves."

The past few years have witnessed an economic shift greatly favoring motor transport. The field for motor transport has consistently widened.

Railway officials have readily admitted that for intra-city movement and for inter-suburban service motor transport fills a much needed gap, handling less-than-car-lot business more efficiently and economically.

Mr. Gerrit Fort, Vice-President of the Boston and Maine Railroad, has stated, "the motor truck has come to stay. It represents an economic change in transportation conditions which is little short of revolutionary. There is no use in fighting the motor truck. Within their own field the trucks are unbeatable."

We do not think that we can take the place of the steam railway in long distance hauls. We do not think we can move freight as cheaply as the waterways. We concede cheerfully the function of other mediums, but we do insist that our place be equally recognized.

Motor Vehicles Feeders to Railroads.—The motor bus, the truck, and the passenger car, have temporarily taken some traffic from the railroads and trolleys, but isn't it true that they have been feeders which helped to increase traffic as a whole? Much produce would never reach the market if it were not for trucks to bring it to the railroad station, while scores of people now travel on trains who seldom left home prior to the general introduction of the automobile.

The truck is daily proving its own case. Its increasing use would not be possible if it were not efficient. Whether the truck be placed at work in the city on short or long hauls or in suburban or inter-city work it will usually show a decided saving over the horse-drawn vehicle. There are cases, of course, where the horse should still be used. This is a question to be decided upon on a dollars and cents basis and should be considered by a competent transportation engineer. The cause of some dissatisfaction with trucks in the past has been inefficient operation and cost keeping. I will discuss this point a little farther along.

Looking at the motor truck in a broad way it possesses the following important advantages over horse-drawn equipment:

First: Speed.
Second: Increased Power.
Third: Adaptability to difficult work.
Fourth: Regularity of service.
Fifth: Greater effective delivery range.
Sixth: Publicity value.

Motor Truck Benefits Farmer.—It is not the city man or his family which benefits most from the motor truck. The farmer is typical of one who gets the greatest benefits. When joined with good roads, the motor truck: Gives access to the nearby town and thus ends his isolation; it enables his children to go to better schools (bus lines are now operating that take school children to more than 12,000 schools of a much better type than the one-room school house of old: It gives him more time to work on the farm; the land he buys can be bought for productivity irrespective of whether or not it is near a railroad; it brings supplies of all kinds to his door, including the daily paper and the magazines. It is his connecting link with his market and permits him to move his produce when prices are right.

The truck-using corporations form

but an infinitesimal part of those who gain from motor transportation.

Why Shippers Prefer Trucks.—We find very generally that, aside from the rates, the reasons why shippers prefer motor trucks include: Own control of the shipment; no boxing; door-to-door delivery; regularity of delivery and operation of plants; saving of time; permit carrying lighter stocks with saving in interest.

The truck may have temporarily taken some traffic from the railroads, but in return it has given them a lot of traffic which otherwise might not have been available. Prominent railroad men ask that the truck take the short haul business, which to them has been unprofitable because of congested terminal facilities.

The truck undoubtedly takes traffic from some short haul railroads. Of the 649 railroads in the short line association, more than two-thirds are listed as having less than 25 miles of track, which, under the new order of things, means that they will have difficulty competing with the motor truck and are, to some extent, an economic waste.

Railroads Using Motor Busses.—We find, too, that instead of extending and building branch lines, railroads, trolleys, and even the Chicago "L" road, are making use of motor busses as feeders. President Harding in his last message said: "The motor truck should become a co-ordinate factor in our great distributing system."

Vice-President Lee, of the Pennsylvania, says many bus and truck lines have failed. Undoubtedly many lines were started over routes where profits were not possible, while many others with good prospects were ruined by mismanagement, operating costs and inefficient operation. And yet hasn't that same thing been true of many of our railroads in past years?

The shipper is interested not alone in railroad or truck transportation, but in complete transportation. He must examine his total costs, not that portion which goes to one carrier. It is the public duty of all agencies of transportation so to co-ordinate their facilities as to give the public the best possible service at the lowest possible cost.

Less Than Car Load Business.—From 20 to 25 per cent of the total railroad equipment is absorbed in the carriage of less than 5 per cent of the business and less than 10 per cent of the carriers' earnings comes from this source: less-than-carload freight.

Fifty per cent of the capital investment of the rails is tied up in other than main line facilities. Is it not the duty, then, of the transportation agencies to examine their less-than-carload freight business and to make changes in practice which will cut down their operating expenditure while increasing their net income?

Railroad men generally agree that the short haul field is unprofitable in most cases and belongs properly to the motor truck. The door-delivery service, the terminal and intra-yard use and the service of generating of new business for the rail lines indicate the real sphere of use of the motor truck.

The fields within which complete transportation of goods can be furnished by highway alone or by railway alone are limited. Let me explain that complete transportation covers the moving of the goods all the way from the premises of the shipper to the premises of the consignee.

Trucking Distance 25 to 150 Miles.—There are very few industries or residences in the continental United States, which are not connected with each other by highway and it is physically possible to perform complete transportation of goods by highway, between almost any two industries or residences. But such transportation is most economical only when limited to the movement of goods between homes or industries which are within reasonable trucking distance from each other. The determination of such reasonable distance depends on many conditions and a competent truck expert will place it anywhere between 25 and 150 miles. Of course, there are emergencies and peculiar industrial conditions which, in rare cases, make trucking economical over a distance of several hundred miles, but such cases are negligible in the consideration of the whole field of highway transportation.

On the other hand, comparatively few industries and practically no residences are connected with each other by railway. Therefore the field for complete transportation of goods by railway is restricted to the movement of car-load freight between those industries which have direct rail connections.

In view of this situation it is inevitable that there will be an increased common carrier use of the truck. In these cases franchises should be granted and the carriers required to operate on fixed schedules over definite routes. Since any charge against transportation is a charge against the consumer, we do not believe in transportation taxes, but we do not ask that other agencies be taxed and we exempt. All we demand is that there shall be no discrimination in taxes against any unit in completed transportation.

Some people like to say, tax the motor truck operator. He gets the benefit. Did you ever know anyone who drove a motor truck for pleasure? He drives because the consuming public demands the service.

Occasionally we hear a complaint from a railroad official that it is unfair to build roads alongside of railroad tracks because they put highway transportation in direct competition with the railroads, which in turn have to pay part of the cost of construction of the highway. That seems a a reasonable basis for a complaint until we begin to analyze the question.

Railroads Paralleled Highways.—It should not be overlooked that the railroads were the first to parallel our highways. Later the trolley lines paralleled the railroads, and now public demand requires the improvement of the highway to care for increasing travel.

The highways thus improved are intercity roads over which there is ten times as much passenger travel as truck travel. These car owners are probably the biggest payers of taxes in that vicinity.

A major part of the trucks using it are owned by business men or corporations in that vicinity, who have contributed heavily in taxes for the building of the highways.

Much of the travel on those highways are with trucks and busses bringing merchandise and people to railroad stations for long haul travel.

These intercity roads are required by the community. Light feeder roads are built back into the agricultural sections, all leading to the main highways and the big towns where the markets are located. These big towns are naturally connected up by the highways the same as they are by railways. The rail lines undoubtedly lose some traffic, but in the long run their gains far outweigh their losses.

Congress, in its last federal appropriation for highways, provided to some degree for the upkeep of these main traveled lines used by everybody in the state, and even by those out of the state.

Cost Keeping for Motor Truck Operation.—I have mentioned the necessity for efficient operation and cost-keeping covering motor truck equipment. Motor trucks are wage earners. They prove the right to consideration in our transportation by the extent of the economy which they effect. Whether to use motor trucks or not must be determined upon a dollars and cents basis.

Bear in mind that the cost of operation per day, of the unit, does not tell the whole story. The work capacity of the unit involved is even more important. That is, how much work will the respective units perform per day? It all must be brought down to a cost per ton mile basis in order to obtain a comparison. Even with the cost per ton mile at hand you will not have the true answer unless you are sure your equipment is being operated efficiently. I will discuss this point a little later.

It is only in recent years that proper attention has been given to the question of securing the real cost of operating delivery equipment. We know fairly well what it costs to operate gasoline trucks, but without question there is still room for improvemen in this direction. Without a standard cost system, comparative figures will not mean much. Unless costs are figured on the same basis and in the same manner a comparison of these figures will cause endless confusion and argument. I recommend to you the adoption of a standard set of forms in compiling your delivery costs covering both motor trucks and horses and other delivery equipment. By using a standard method, a comparison of cost figures would mean something and if one member found his cost above the average, he could quickly find out why and endeavor to correct the situation.

The Truck Owners' Conference, Inc., have formulated a National Standard truck cost system. Their first effort resulted in such a compli-

cated system that it was not practical in many cases. They have a simplified form, however, which is proving to be very popular and at the same time tells the truck operator what he should know about his operating costs.

Let us consider for a moment the subject of efficient operation of delivery equipment. The amount of work that a truck can perform depends largely upon the efficiency with which it is handled.

I wonder how many truck operators realize the importance of the lost time factor and what it is costing them every day? How many traffic managers in control of trucks have set out to study first hand what is a satisfactory day's work for a truck? How many traffic managers have ridden all day on delivery vehicles, making time studies of the vehicle, the driver and the helper, during the work day?

The Question of Lost Time Factor.—The question of the lost time factor is worthy of our earnest consideration. The lost time factor usually contributes more toward the operating cost of motor trucks than do the items of depreciation, repairs, gasoline, etc., put together.

In a general way, most progressive truck operators have realized this. They will tell you that "it doesn't pay to have a truck stand around doing nothing," and they seek in probably a halfhearted way to keep their trucks moving.

But if the prime importance of this lost time factor was fully understood by motor truck owners and if it were recognized what enormous savings or earnings could be effected in transportation costs by reducing this factor to the absolute minimum, the demand for motor trucks would be so great as to swamp the manufacturers completely.

How shall we arrive at the lost time factor? The best way is to make a time study of the truck's operation. An analysis of the time during which the truck is not in motion will quickly show why the truck is not earning more money. This unprodutcive time should then be cut down to the very minimum by endeavoring to improve the loading and unloading conditions as well as eliminating other delays which are made apparent by the time study. This will permit the operator to arrive at a standard trip time against which the daily record of operation should be checked.

Need for Standards.—As a basis for comparison of trips a standard should be established covering the following items:

1. Minimum loading time.
2. Minimum unloading time.
3. Running time per mile.
4. Average loss of time on account of poor drivers, traffic delays, etc.

Such standards should be established for various lengths of haul. This gives an exact basis for figuring the time required for any length of trip. A definition of a day's work should be conceived by the traffic manager at his office, but determined by studies of actual conditions in the field.

In the short time available for the discussion of such a large and important subject, I could only hope to touch upon a few of the high spots. I will feel well repaid if I have impressed upon you the value of making a real analysis of your transportation problems. The adoption of a standard cost system would be well worth careful consideration. I can summarize my message in two short sentences.

Be sure your delivery costs are accurate. Make sure you are operating your delivery equipment efficiently.

Special Committee Starts Survey of California Highway Needs.—A committee of nine prominent citizens has been appointed by the governor of California to study the highway needs of that state, following the passage of a bill by the last legislature providing for a survey of the highway system. This committee is authorized to study the highway needs and road financing problems of the state. The members of the committee, who serve without pay, also are authorized to propose a complete system of state roads, study types of construction and materials to be used, to recommend the inclusion of additional mileage, the exclusion of certain legislative roads now included in the system, and the time to be occupied in the completion of the system. The committee is required to submit to the legislature two years hence some plan for financing the enterprise. State Highway Engineer R. M. Morton estimates that it will require $200,000,000 to complete the 6,500 miles of highway now included in the system.

The Use and Care of Road Machinery

By W. E. VOORHEES,
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The best results in road building can only be obtained by the use of machinery. The most conclusive evidence that can be offered to prove this statement is found in the fact that every forward step in road improvement has been paralleled by a corresponding advance in the development of road building machinery. The marvelous progress that has been made during the past quarter of a century in the work of building types of roadways calculated to withstand the ravage of modern traffic can be attributed largely to the fact that improved mechanical appliances have made possible the economical construction of such highways.

Loading Gravel from a Pit Into a Bin in New York State.

Twenty-five years ago practically the only roads we had in this country were of the common earth variety. The machine that was used almost exclusively in caring for these roads was the four-wheeled road machine or road scraper such as we have in use today, except that the machine turned out at that time was naturally a cruder and less efficient piece of equipment than the present day reversible road grader. In cities and in the more wealthy country districts some permanent roads, mostly of the water bound macadam type, were to be found. The two machines used in the construction and maintenance of such roads were the rock crusher and the heavy steam roller.

It is safe to say that the fingers of one hand would count the only types of machines that were used in road construction thirty years ago. Today, if you will examine the advertising columns of ENGINEERING AND CONTRACTING, you will find there are more than fifty different machines that have some place in modern road work.

Today, in the construction and maintenance of dirt roads, several different types of road graders, ranging in weight from 500 to 8,000 lbs are being used. Steam and gasoline tractors are gradually taking the place of horses or mules as the motive power for such machines. In the West, where wide roads are the rule, it is not at all common to see a mammoth

road machine, with a scraper bar twelve feet long, being pulled with an eighty horsepower gasoline tractor. The road planer, unknown in the East, is also being used to a considerable extent in some of the Middle Western States. This machine is equipped with two sets of long blades and is capable of planing off the entire surface of a wide road at one operation. For dirt highway maintenance small road graders and all kinds of road drags, from the crude split log affair to the modern steel drag with adjustable blades, are being used.

In permanent road building many varieties of machines are used. Among others, might be mentioned the rock crusher, with elevators, screens, bins and conveyors; steam and gasoline road rollers of the three-wheeled and two-wheeled types; steel scarifiers for picking up old roads; various kinds of appliances for spreading oil; kettles for heating heavy bituminous materials; street sweepers, street sprinklers, concrete mixers, steam shovels and motor trucks for hauling materials. This does not include such tools for asphalt work as fire wagons, tampers, pavers, etc.

It would be quite interesting to know how much money is yearly expended in the purchase of road and street making machinery. It has been stated that in this country we are spending close to one billion dollars per year in making new and repairing old roads. Of this fabulous sum it has been estimated that close to one hundred million dollars per year goes into the purchase of road building machinery and supplies of all kinds. Some idea as to the part that road machinery is playing in modern road building can be grasped when we stop to consider the immense amount of money involved in the annual purchases of equipment.

It will only be necessary in this article to speak generally as to the use of road machinery. Any man can operate a road machine—not every man is an expert at the job. Manufacturers publish plan instructions for the operation and care of their machines. Necessarily they can not furnish the brains and judgment for putting these instructions into effect. Road graders are built very simply and have been on the market for so many years that they are a familiar mechanical appliance. In every community men can be found who can operate such machines with very satisfactory results.

Making a Good Dirt Road with a Grader and Gasoline Tractor in California.

In the use of the road drag there are only a very few rules which it is necessary to observe. These might be summed up briefly as follows: Don't drag a road when it is either wet or dry; do the work when the soil is damp. Don't use a drag on a stony road. In dragging a road, work from the sides toward the center and thus retain the crown of the road.

The construction and maintenance of any type of permanent highway such as the bituminous bound macadam or concrete is becoming more and more the work of experts. By this is meant that men must know how to build such roads before they successfully carry on the business. The fact that

a man knows how to build a high class road presupposes that he is acquainted with the proper kind of machinery to use in its construction. If he does not make a thorough study of machinery in its application to his work, he will most assuredly lose out in the end. The operation of a rock crusher, a big paving mixer or a steam road roller requires the services of a mechanic. A man must know his machine to get the best results from it.

Nothing responds to good treatment like a piece of machinery. Judging from the way some men treat themselves I should say that the average man will stand a lot of abuse and still come up smiling. With a machine it is different. Let one little nut get lose, a gear work out of place, or a spark plug spring a leak and the whole mechanism is out of order. Two different men own and use exactly the same make of machine. One of them gets well nigh perfect satisfaction; the other declares that he has a lemon. A little investigation will usually show that the fault is with the human and not with the mechanical factor. One man is constantly looking over his machine and correcting the difficulties even before they come to the surface; the result is a machine that gives good satisfaction. The other man leaves the machine to take care of itself; the result is that he is subjected to continuous trouble and annoyance.

Eternal vigilance is said to be the price of liberty. Eternal vigilance is also the price of smooth, satisfactory running road building machinery. Road machinery should be looked over frequently and thoroughly. Bolts should be kept tight; worn and broken parts should be replaced; bearings should be lined up so that lost motion will be eliminated. In the use of road machinery an ounce of prevention is always worth a pound of cure, and a little money spent in keeping a machine in proper working order in the beginning may save a great deal of money if the machine should break down in some important part at a time when it is badly needed.

Road machinery is playing an increasingly important part in the work of improving the highways of this country. Millions of dollars are now invested in road building equipment; many more millions will be expended within the next few years. It is therefore, of the utmost importance that every man who has anything to do with the practical work of road construction should feel alive to the necessity of learning all that he possibly can concerning the use and care of road building equipment.

The Dignity of the Road Builder

We hear much about the "dignity of labor". Many other professions and callings have their own particular graces and embellishments. But what about the dignity of the road builder? We seldom hear such an expression in the ordinary transmission of thoughts and ideals which govern the everyday information of the world Nevertheless when mentioned, the road builder enjoys dignity of no low degree. Centuries ago the inhabitants of Thebes wished to disgrace Epaminondas because he had failed in an attempt to capture the city of Corinth, so they elected him telearch, or street cleaner. Thereupon Epaminondas rebuilt, ornamented, and beautified the streets until he raised the position of telearch from one of ill repute to that of the highest dignity in the city. H. G. Wells selected the six greatest men in the history of the world, and one of the reasons he gave for leaving the name of Alexander the Great off the list, was because with all his great conquests and brilliant victories, he had failed to establish any good roads. John Tyler at his retirement from the Presidency of the United States, had fallen so low in the scale of popularity that his neighbors elected him road overseer in his home precinct. The law at that time empowered the overseer to call out the farmers to work the roads whenever he saw fit. To the surprise of all, Tyler accepted the job, and worked the roads with such frequency and energy that he developed the best roads in the county. Two years ago a great American statesman said in speaking to the young men of Lincoln, that the safest, sanest, strongest, and soundest principle for a politician to advocate was this, "A hard road to every farmer's door in America." So it is that he who buildeth a good road is greater than he that taketh a city.—From a Report of the Nebraska State Department of Public Works.

Behavior of Concrete Roads Under Service Conditions

Factors That Influence Condition of Surfacing Outlined in Paper Presented June 28 at 26th Annual Meeting of American Society for Testing Materials

By A. T. GOLDBECK
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It is difficult to conceive of any type of concrete structure which is subjected to a more complex set of influences than is a concrete road surfacing. Investigations of the past few years are just beginning to show us something of the stresses to which concrete roads are subjected by the many kinds of forces acting upon them.

Let us consider the concrete road beginning from the day the concrete is laid, and let us look into the many factors which are at work to influence the condition of the surfacing throughout its period of life. The concrete is deposited on the subgrade and slowly hardens. At the very beginning of the hardening mass for it is at this stage that hair cracks develop.

Action of Natural Influences on Concrete.—The concrete is "cured" by the use of some means for keeping the surface wet, such as frequent sprinkling and with the use of a wet earth covering, by ponding, by straw covering, and in the last few years by a sprinkling of calcium chloride which acts as a hygroscopic material. After a short period of curing, the moisture is allowed to dry out from the concrete, and, as has been well established, shrinkage now takes place and the concrete slab by contraction slowly moves over the subgrade. The forces of friction thus developed between the subgrade and the slab produce tensile stress in the concrete, and when this stress exceeds the tensile strength, transverse cracks form at frequent intervals. Changes in temperature of the slab also expand and contract it and cause it to slide over the subgrade, again producing compressive or tensile stress in the slab. During the day, the top surface is heated by the sun to a higher temperature than the bottom surface and naturally the slab is warped downward at the edges and corners. During the night the reverse is true; the corners warp upward. In many cases they actually leave the subgrade. During periods of dry weather, the top surface becomes quite dry, while the bottom surface is in contact with the more or less moist subgrade. Under such conditons the concrete might be warped and bent upward at the sides and ends. In the meantime the varying moisture conditions in the subgrade are swelling and shrinking the soil in a most non-uniform manner and the road is offered non-uniform support. When cold weather comes, the ground freezes. Very naturally the entire road is raised, due to the expanding action of the frost, and if it happens that snow is cleared from the center of the road and is heaped up along the sides, the insulating blanket of snow prevents as deep a penetration of frost at the sides as at the center. The center of the road is then heaved more than the sides, which then overhang their center support like two cantilever beams, and through overstress thus created, the slab is cracked down the center. Frost action within the concrete itself also must be resisted, and this requires a dense, strong concrete of low absorption. A number of natural influences then have been at work even before traffic is turned onto the road.

Action of Traffic.—The heavy fast-moving loads of the present day produce high stress in concrete slabs under certain conditons. This is especially so with heavy fast-moving vehicles having well-worn solid rubber tires. Impact stresses are apt to be high and this is especially true in the vicinity of joints and on roughly finished spots in the road. Not only does this heavy impact produce high bending stress, but the local pressure on the immediate surface is considerable. There are concrete roads in which exceptionally poor coarse aggregates have been used largely as a matter of expediency, which are now showing signs of distress from the action of traffic.

When we add to all of these influences the troubles which are apt to

occur due to the use of unsuitable materials, too much water, or greatly interior workmanship, coupled with a design ill-adapted to the conditions of subgrade and traffic, the wonder is that concrete roads are capable of giving the most excellent service which, in general, they are giving under our present-day rubber-tired traffic.

The concrete road, however, like all other types of roads, develops certain defects, some of which are serious and some of which are of little consequence in their effect on the service value of the road.

In collecting information on defects in concrete roads I have been fortunate in having recourse to data supplied by the District Engineers of the U. S. Bureau of Public Roads, having headquarters in various parts of the country. The bureau representatives in the various states likewise have presented their ideas through the District Engineers, so that the principal defects now occurring in concrete roads should in this way have been pretty well observed and reported.

Defective Design. — The concrete road has had its share of failures due to the use of a design which has been ill-fitted for the traffic and subgrade conditions. There have been reasons for poor design in the past, for many principles are only now beginning to be recognized and understood, and moreover, our oldest concrete roads have witnessed an increase in variety and intensity of traffic such as has never been recorded in a similar period in history. Again, the phenomena in connection with the movement and accumulation of moisture in the subgrade and the action of moisture on various kinds of subgrade materials have never been given through study.

Truck wheel loads have been increasing in weight with great rapidity; speeds have been ever increasing, and in the absence of sufficient legal restraint on such loads, very naturally cases have arisen where the high stresses produced by loads coupled with inadequate and non-uniform support offered by the subgrade have resulted in the structural failure of the surfacing. The means for overcoming defective soils, the knowledge necessary for adequate design, and legal restrictions necessary for the control of maximum wheel loads and speed are now almost at hand, and will serve to eliminate structural failures from these causes in the future.

Defects in Concrete Roads Other Than Those Due to Faulty Design.—There are other defects occurring in concrete roads, some of which are of no particular importance, and others of which that are quite serious. These defects as observed by the District Engineers of the U. S. Bureau of Public Roads, by their assistants and by the author are listed as follows:

1. Cracking:
   - (a) Transverse;
   - (b) Longitudinal;
   - (c) Diagonal cracking;
   - (d) Corner cracking.
2. Hair Checking of the Concrete Surface.
3. Surface Irregularities in the Pavement as Constructed:
   - (a) Due to lack of uniform consistency of the mix;
   - (b) High joints;
   - (c) Slumping of concrete on grades;
   - (d) Unevenness of side forms.
4. Settlement of the Pavement.
5. "Blow-ups" of the Pavement.
6. Slipping of Joints.
7. Spalling at Concealed Joints.
8. Surface Scaling:
   - (a) Due to fine aggregate;
   - (b) Too wet a mixture or excessive finishing;
   - (c) Calcium chloride curing;
   - (d) Freezing.
9. Surface Raveling.
10. Surface Wear.
11. Concrete Disintegration:
    - (a) Due to alkali;
    - (b) Defective materials.
12. Surface Pockets:
    - (a) Due to dirty aggregate, balls of clay, coal, wood chips, soft material.

Perhaps the most common defect noticeable in the concrete pavement is that of cracking, the most frequent cracks being transverse cracks across the width of the pavement. Longitudinal cracks parallel with the edges of the pavement, diagonal cracks and corner cracking also occur.

Transverse Cracks.—It seems inevitable that transverse cracks must form in concrete pavements, because concrete will not stretch to the amount made necessary by shrinkage produced through drying out of moisture and by decrease in temperature. This becomes evident when we realize that concrete shrinks approximately 0.0004 to 0.0005 in. per inch of length due to drying out of moisture and approximately 0.0005 in. per inch of length

due to 100° F. fall in temperature, a possibility of 0.001 in. shrinkage per inch of length due to these combined causes. This is equivalent to 0.1 ft. per 100 ft. with a combination of these extreme conditions.

The probable deformation of road concrete when cracking takes place does not exceed 0.02 ft. per 100 ft. With a deformation of this amount, transverse cracks are bound to form in any considerable length of concrete road. It is a question, however, whether they should be considered as a defect, as they may be maintained with little expense and in such a manner that no harm results from their presence. No doubt, transverse cracks likewise form through subgrade settlement and through the bending action of heavy loads which produce a too high fiber stress.

Longitudinal Cracking.—Longitudinal cracks occur, in general, due to non-uniform support offered by the subgrade. In those parts of the country where frost penetrates to a considerable depth, longitudinal cracking is quite prevalent. This is due, perhaps, to the unequal depth of frost penetration at the side of the road as compared with the center. It has been observed, especially where snow is piled at the sides of the road, the center being exposed, that frost will penetrate deeper at the center than at the sides, thereby producing greater vertical motion at the center through the expanding action of a deeper layer of ice. The concrete surface having insufficient resistance to bending develops longitudinal cracking. The practice of allowing wood side forms to remain in place seems to have led to cracking. The forms are raised by frost, a water reservoir is thus formed under them, and this aids in saturating the subgrade.

Another condition which produces longitudinal cracking has been observed in accentuated form particularly in the adobe soils of California. These soils swell and shrink to a considerable degree when their moisture content changes. Very naturally the moisture changes are apt to be higher at the sides of the road than at the center. Cases are on record of the subgrade having shrunk 1½ in. away from the under side of the concrete slab. Under such conditions, longitudinal cracks might form within several feet of the side of the road. The remedy for such conditions, in part at least, lies in a proper treatment of the subgrade. It is stated that subgrade preparation by plowing, harrowing and re-rolling to a considerable depth, making for homogeneity and waterproofness, greatly inhibits cracking from subgrade causes. Another treatment under the same conditions involves the use of a layer of sand between the subgrade and the slab. Experiments in which admixtures such as portland cement, hydrated lime, sand and bituminous materials have been harrowed and plowed into the underlying subgrade to decrease its shrinkage factor, have shown promising results.

Longitudinal cracks of themselves are not particularly harmful. There is a tendency, however, to develop forked cracking which produces weak spots in the road surfaces, and for this reason the more recent pavement designs have called for a center longitudinal joint in the road so that the positon of the longitudinal crack is predetermined and confined to a straight line. Certain types of longitudinal cracks seem to develop, beginning at the transverse expansion joint and extending perhaps ten or more feet into the slab. Investigation of such cases seems to point to defective installation of the bituminous expansion joint, which has allowed the concrete no room for expansion at the sides owing to the use of too short a length of joint-filling material. On the other hand, the lateral resisting moment of the slab is least near the joint, and for this reason it is natural that longitudinal cracks should begin at the joint.

Diagonal Cracking. — Diagonal cracking is another type of cracking which is particularly objectionable since it produces acute-angled projections in the slab which are readily broken off. Proper design will eliminate this trouble.

Corner Cracking.—Corner cracking is noticeable particularly under soft subgrade conditions, heavy loads and narrow surfacing. It is claimed that the frequency of such cracking is accentuated by a sudden lowering of the surface temperature such as occurs at night, the corners of the slab then being warped away from the subgrade. Such cracks occur on the average from, perhaps 2 to 3½ ft. from the corner. The small slab thus produced is readily pounded into the subgrade and high maintenance expense

results. Under unfavorable conditions, this becomes a serious defect in concrete roads which is now being remedied by a design which calls for a surface thicker at the sides than at the center, just the reverse of concrete road practice of several years ago.

Hair Checking.—In a number of concrete road projects, minute cracks appear on the surface of the pavement very shortly after the concerte is placed, and these constitute a minor defect which might possibly interfere with the future integrity of the pavement. Several causes for this defect seem to have been demonstrated. It seems to be pretty definitely established that hair checking is due in some cases to a subgrade condition caused by the unusual capacity of some soils to draw water and moisture rapidly from the concrete. Then, too, the non-uniform swelling of a non-homogenous subgrade upon the absorption of moisture is a possible cause for hair checking and cracking. Wetting down of the subgrade for several days previous to the placing of the concrete lessens this defect. It has been observed likewise that hair checking is accentuated on very warm and windy days. The careful laying of strips of wet burlap over the surface as soon as practicable after finishing seems to be an aid in reducing hair checking. Observation seems to point to dirty aggregate as another cause for this trouble. In a number of pavements, hair checking does not seem to be extending with the continued use of the pavement, nor does any particular harm seem to result. Nevertheless, this is a structural defect which offers possibility for harm.

Surface Irregularities in Pavement as Constructed.—Smoothness of the concrete pavement surface is sometimes rendered impossible, notwithstanding good finishing, due to lack of uniformity in the consistency of various batches of concrete. Because of unequal settlement of the alternate wet and dry mixtures, bad riding qualities and rapid depreciation of the pavement result. This defect can be avoided by proper care to maintain a uniform consistency.

High joints are a defect produced through poor surface finishing at the joints and can be eliminated if the proper use is made of a templet for insuring the evenness of the surface finishing.

It has often been observed on grades of over 4 or 5 per cent that the pavement is noticeably rougher than on level stretches. This is due to the fact that the wet concrete has slumped or moved down grade after it has been finished to an even surface. This probably is aggravated in cool weather when the concrete sets very slowly. It is difficult to overcome when a combination of heavy grades and cool weather is encountered during construction. In such cases the final finishing must be delayed until the concrete is stiff enough to retain its position after finishing.

Unevenness of side forms is an inexcusable construction defect and results in an uneven surface.

Settlement of the Pavement.—Many pavements become defective in time due to settlement of new fills on which they are constructed, particularly adjacent to bridge abutments. The surest remedy seems to be to defer the placing of the pavement until the vertical settlement of the earth is complete. Heavy reinforcement is also of value under these conditions.

Pavement "Blow-Ups."—Blow-ups of the pavement are almost always occasioned by the expansion of the concrete and they occur at the apex of grades and at other places which can be traced to faulty construction. In a number of cases examined, it has been found without exception that these blow-ups occur on pavements which were laid during cold weather without expansion joints, and resulted largely from what might be called "tapered noon-day joints." In cases where no attempt has been made to construct a vertical joint at the noon-day interval and the length of time is such as to permit the initial setting of the concrete, a "tapered joint" results. These joints in all cases constitute a plane of weakness which ruptures usually from expansion stresses.

Slipping of Joints.—Where bituminous-filled joints are used, in a number of instances there seems to have been a decided tendency for adjacent slabs to slip. Extraordinary care should be taken to insure the placing of these joints at right angles to the pavement surface. A few degrees variation from a right angle can cause trouble. Such slipping constitutes a very serious defect and generally results in very rapid disintegration of

the slab and the necessity for its renewal.

Spalling at Concealed Joints.—Oftentimes the mistake is made of placing prepared joint fillers so as to form "concealed expansion joints," a thin layer, say one inch, of concrete covering the joint material. This defeats the purpose of the joint filler. When the concrete expands, the excessive compression produced in the thin web of concrete at the surface spalls off a layer of the surface and produces an inequality which requires expensive maintenance and seriously mars the appearance of the pavement. Such defects can be entirely avoided by proper design of the joint.

Surface Scaling.—It seems to be evident that sand containing too high a percentage of particles passing a 100-mesh sieve will produce surface scaling, probably because of the accumulation of the finest material at the surface. For this reason it is well to limit the amount of material by elutriation to less than 3 per cent, and there should be not more than 5 per cent of particles passing the 100-mesh sieve.

Too wet a mixture and excessive finishing are probable causes for the accumulation of a weak surface layer which will begin to scale at the end of several years. Particular care must be taken not to use a consistency wetter than is necessary for the proper working of the concrete.

Concrete road construction is often carried on beyond the safe working season, and notwithstanding precautions against freezing, many concrete pavements have been nipped by frost. In most cases, the surface only is attacked, and as a result the surface layer becomes detached from the main body of the concrete, exposing the coarse aggregate and leaving a rough surface which is subjected to the possibility of rapid deterioration. The safest plan is to stop concrete pavement construction when the temperature is apt to approach a freezing temperature, but if economy demands that the road be finished before the approach of winter then the usual cold weather precautions for concreting should be applied. It would seem also that an accelerator might well be used under such conditions.

Surface Raveling.—In a number of instances it has been noted that the surface of the concrete, especially in the vicinity of cracks and expansion joints, is showing excessive deterioration due to raveling. In other cases the entire surface is showing signs of disintegration. In some of these instances, undoubtedly the extremely smooth surfaces presented by the coarse aggregate are responsible. In others, the extremely poor quality of the coarse aggregate and of the fine aggregate, or of the concrete in general is responsible for rapid deterioration.

Surface Wear.—The general surface wear which takes place on concrete pavements is quite insignificant, although there are several cases where very noticeable wear has taken place. For illustration, pavements finished late in the fall and thrown open to winter traffic have been badly grooved in localities where snow has led to the tracking of motor vehicles equipped with tire chains. In certain localities the local aggregates are exceedingly soft and friable. Pavements constructed of excessively soft materials such as these are showing signs of wear which may be a determining factor in their life. In general, however, well-constructed concrete pavements in which aggregates of a satisfactory quality are used do not wear excessively under the action of our present-day rubber-tired traffic and it is hardly likely that general surface wear through abrasion will ever be a factor in determining the life of a concrete pavement.

Disintegration of Concrete.—The disintegrating effect of certain types of alkali, principally the sulfates of sodium, potassium and magnesium, are well established, and cases are on record in our western districts in which alkali seems to have played a prominent part in causing rapid disintegration of certain concrete pavements. As the alkali must reach the pavement through capillary action, it would seem that where concrete pavements are to be laid on a soil highly charged with alkali salts there should be interposed between the concrete and the underlying soil a layer of material having low capillary action. Several inches of sand should be quite effective for this purpose.

Defective Materials.—Concrete roads, like other concrete structures, have disintegrated because defective materials have been used. Projects have been constructed in spite of laboratory reports condemning the fine aggregate, and these projects

have shown signs of disintegration within a comparatively short period after opening them to traffic. Dirty aggregates, especially those containing clay-covered particles, organic matter in the sand, fine aggregate which has too high a percentage of fine particles and clay, all have been used in concrete road construction, and all have resulted in poor concrete. Screenings for use as a fine aggregate are to be looked on with considerable suspicion and certainly when they are permitted their grading must be governed so as to insure a workable concrete which will not be highly aborbent and which will not contain a high percentage of dust.

There is no excuse for poor concrete roads from any of the above causes. Unfortunately, however, careless or ignorant inspection coupled with studied neglect of laboratory warning has resulted in poor materials being used in a number of concrete roads in the past.

Surface Pockets.—Surface pockets are to be found in a number of concrete roads. These are caused by soft pieces of material in the aggregate which have been deposited or have gravitated toward the top surface during the finishing process. Such pockets are to be found in roads built with all types of aggregates but particularly in those having gravel aggregate. They are due to clay balls, soft pieces of gravel, chips, coal or other foreign substances which have come to the surface of the concrete.

Light slag aggregate when used in concrete road surfaces produces pitting of the surfacing. In general, however, when these pits are of comparatively small size, say not over one inch in diameter, they do no particular harm and are not to be considered as a particularly serious defect.

Defects Can Be Eliminated by Proper Design and Construction.—With the possible exception of cracking, there is hardly a defect listed and described above which cannot be almost entirely eliminated from concrete roads through the use of proper design and construction methods, satisfactory materials and their intelligent combination. The facts which have been gained by observation of existing roads and by special investigations are giving the progressive engineer information which will place him in a position to practically eliminate all of the serious defects of concrete roads. Lack of knowledge of the mechanical principles of design, in appreciation of the necessity for careful attention to details of construction, the use of poor materials, failure to apply the known principles of good concrete manufacture, failure to obtain homogeneity to both subgrade and concrete have led to all of the defects we have been discussing. Probably, defective materials which our ordinary tests have not detected are responsible for some concrete road failures. Certainly, however, these defects are but a small fraction of a per cent of the total concrete mileage and the main defects can be avoided through the application of present knowledge.

Concrete for pavements must have high flexural and tensile strength in order to minimize the frequency of cracking, it must have high density to better enable it to exclude moisture; the aggregates must be well bonded together to resist the disintegrating action of traffic, and the mixture must be homogeneous in proportions and consistency.

Perfect concrete road building is an intricate operation which too often is entirely under the control of inspectors who are not well versed in the technique of materials or construction. They do not understand the great importance of careful attention to details. By all means, concrete road inspectors and, in fact, inspectors on other types of concrete construction should be schooled in the causes and effects in connection with the various operations under their control. It is absurd that millions of dollars worth of materials and expensive construction should be left at the mercy of any but the most competent of inspectors.

I think I can safely say, notwithstanding the fact that the above defects in one form or another are to be found distributed over the thousands of miles of concrete roads in this country, the concrete pavement has paid for itself in traffic returns manyfold and has rendered most excellent service.

12,000 Men Employed on Missouri Road Work.—The State Highway Commission of Missouri has work under way on 412 different road building projects with an average of at least 30 men per project.

Testing Road Oils

Use of Air Bath in Determination of Solid Residue Described in Paper Presented June 28 at 26th Annual Meeting of American Society for Testing Materials

By H. F. CLEMMER and H. C. HELMLE,

Engineer of Materials, and Assistant Engineer of Materials, Illinois Division of Highways

During the past few years the increased use of road oils in Illinois has made it necessary that these materials be purchased from a great number of refineries whose processes and products vary to a considerable degree. In making the tests on these oils, difficulty has been experienced in securing uniform results on the test known as "Solid residue of 100 penetration."

Methods of Evaporating Road Oil.—There have been in general use two methods of evaporating a road oil to a residue of desired penetration, namely, the sand bath and the hot plate. Since 1915, however, the testing laboratory of the Illinois Division of Highways has made use of the ordinary gas hot plate, finding that it affords greater ease of temperature control as well as greater accuracy of test than was possible with the sand bath.

In recent years, many road oils obtained by pressure distillations and cracking process have been sold in the state. Due to the nature of these materials, considerable trouble has been experienced in obtaining, with existing methods, uniform results in solid residue determinations. The appearance of a coky residue or of coke deposits on the sides of the residue box has led to the belief that the inconsistencies in results are caused by local heating, during the evaporation, of the oil on the sides or bottom of the residue box. Cracked or burned road oils, being originally of a coky nature, contribute more readily to these conditions of irregular heating and it is with these materials that the greatest discrepancies in results occur.

The Air Bath Apparatus.—In order to provide a method which would eliminate these conditions of local heating and give uniform results on both cracked and skimmed products, the air-bath apparatus was designed and has now replaced both previous methods in the inspection of oils by the Illinois Highway Laboratory. The apparatus shown in Fig. 1 is the same as that used in the pervious gas hot plate method with the addition of a metal ring 3 in. in diameter and 1¼ in. in height. The residue box fits snugly through the top of the ring and is supported at a distance of ¼ in. from the surface of the hot plate by a wire shelf constructed inside the ring. The inside diameter of this

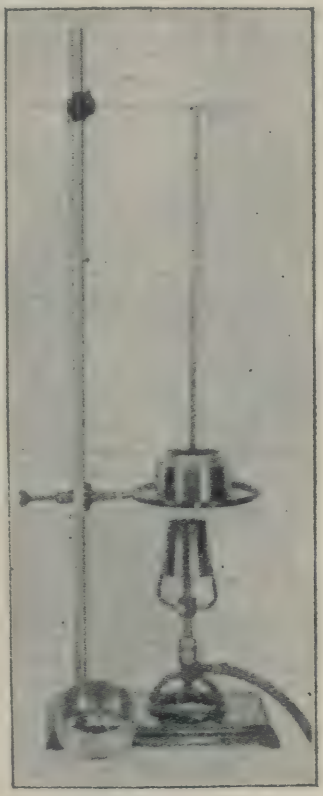

Fig. 1. Air Bath Used in Determination of Solid Residue.

ring is ½ in. greater than that of the residue box, so that on the side and bottom of the box there is an air space of ¼ in. The air bath may be used in conjunction with either an electric or gas hot plate and in either case provides for an even temperature at all points where the oil would come in contact with the sides and bottom of the residue box during its evaporation to a solid residue. In addition to

the fact that the air bath eliminated local heating and coke deposits, it was noted during the tests that very little attention of the operator is required to maintain a constant temperature throughout the period required to evaporate the oil.

Effect of Temperature Control.—In order to determine the effect of temperature control upon the solid residue test, seven grades of oil were evaporated between three separate temperature ranges: 230 to 240 deg. C., 250 to 260 deg. C., and 270 to 280 deg. C. Four samples of each grade of oil were heated at each temperature range, making in all 84 determinations. Table I gives the average of four determinations for each grade of oil at each temperature range and shows the variation in the percentages of solid residue due to the difference in temperature at which the tests were run. The importance of a uniform temperature is demonstrated in the results obtained, being especially illustrated in the case of sample 22-2096 which varied 12 per cent with 40 deg. C. difference in temperature. The number of hours required to make each run was also recorded and shows a proportionate increase in variations of results with the increase in length of time required to evaporate the oils.

From this investigation it has been shown that temperature control, being a vital factor, should be considered in all methods for the determination of solid residues. In the sand bath method it is difficult to control the temperature of the oil and although even temperature is more easily maintained on the hot plate, direct contact of the residue box with the hot plate lends to the formation of a coky residue and causes wide variation in the percentages obtained. The air bath, quickly adjusted to the proper temperature and easily controlled, has been found to be adaptable to the determination of solid residue on all types of road oil.

A Hauling Record

The Consumers Company of Chicago reports the following record of haul during one day with a Warner semi-trailer.

During this day, they hauled 630 tons of crushed rock with the single semi-trailer unit. This was done in the following manner: The time of operation was eleven hours; the net load each time was fifteen tons; forty-two trips were made during this day and the round trip was three miles.

Conditions were very favorable, the truck being loaded with a steam shovel and dumped with no delay at all. The hauling cost, as near as we can figure, amounted to four dollars an hour or forty-four dollars for the day which made the cost per ton approximately seven cents.

Geodetic Control of City Surveys

While the use of geodetic control and methods by the cities of this country has grown very slowly in favor with city engineering officials, yet that growth has been sufficient to indicate a strong tendency toward the ideal of precise and comprehensive surveys for all city planning work. For this reason a recent publication of the U. S. Coast and Geodetic Survey is particularly timely. The publication presents to municipal engineers a comprehensive report on the methods by which geodetic control, already covering a large portion of our country, can be utilized and to suggest the use of geodetic methods to other engineers. A copy of Special Publication No. 91 can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 20c.

TABLE I.—PERCENTAGES OF SOLID RESIDUE (100 PENETRATION) AT DIFFERENT TEMPERATURE RANGES

Each value is average of four determinations

	Temperature Ranges					
	230 to 240 deg. C.		250 to 260 deg. C.		270 to 280 deg. C.	
Laboratory Number	Solid Residue, per cent	Time of Evaporation, hours	Solid Residue, per cent	Time of Evaporation, hours	Solid Residue, per cent	Time of Evaporation, hours
22-1899	66	9	64	6	61	4
22-2265	63	4	62	2.5	61	2
22-1968	63	4.5	61	3	59	2.5
22-1969	70	4.5	68	3.25	66	3
22-2030	73	53	68	22	64	13
22-2059	70	37	66	27	62	20
22-2096	72	30	65	23	60	16

Regional and Metropolitan Planning

Principles and Methods Discussed in a Paper Before the Fifteenth National Conference on City Planning, Baltimore, Md., 1923

By GEORGE B. FORD
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What Is Regional Planning?

A farming village can be complete in itself. Within its political limits it can have nearly everything necessary for the complete functioning of its community life. The people who use the stores and industries in the center can often be supported by the surrounding farming belt, all within the limits of the municipality.

However, as the village grows to a town and the town grows to a city rarely are the corporate limits of the municipality expanded to the point where they include the whole surrounding contributory area. As a rule, the larger the community grows, the greater the area outside the city limits which supports and is dependent upon the municipality at the hub.

Controlled as it is by our State laws, the planning of cities and towns has been confined so far to their often arbitrary corporate limits, regardless of the fact that the metropolitan area as an economic unit bears little relation to these limits.

Therefore the logical next step in city and town planning is to find a way of controlling and directing the development of the whole contributory region in the common interest of all living within it. Study of this subject has brought us to the following general conclusions:

1. The character and direction of growth of contributory area beyond the city limits should be controlled by a Metropolitan or Regional Planning Commission, or where such areas lie entirely within a county by a County Planning Commission.

2. Such a Commission should include official delegates from each municipality affected. Each municipality should contribute to the support of its work on a pro rata basis or if that is not feasible it should be supported by private subscription.

3. There should also be a Citizens' Regional Plan Committee composed of representatives of the leading civic and economic organizations of each community within the area. This Committee should cooperate with the Official Commission at every stage of its work. This Committee should interpret the official plans to the public and to the authorities in their respective towns and should aid in securing local backing and support. The Committee should also act as a watch dog over changing official commissions to maintain the continuity of the plans.

4. The official Commission should cause a regional plan to be made which should include every physical feature which could affect more than one municipal unit. It should be made for many years to come and such a plan should be officially recognized by each of the municipalities affected by it.

5. No project affecting more than one community, be it for a thoroughfare, bridge, transit line, railroad, waterfront development, park, public or private reservation, subdivision, building code or zoning ordinance, should be executed without having received the sanction of the Regional Commission as well as of the local bodies affected.

6. All physical improvements affecting more than one community should be paid for by prorating the cost among the municipalities interested.

7. If in a given case the State constitution or laws prevent or hamper any of the above operations, steps should be taken to amend them.

8. Serious consideration should be given to the causes and the effects of concentration of population and, in so far as an undue "load on the land" is found to cause harm, the effect should be mitigated by regulation and means found of encouraging decentralization.

9. Guess work and unscientific judgment should be reduced to a minimum in regional as well as in city planning. Every plan recommended should be the logical deduction from a quantitative as well as a qualitative analysis of all the contributory facts.

10. Everything possible should be done to counteract the sordidness of most larger agglomerations and to bring back to the environment of the city dweller the charm that he craves.

How Regional Planning Differs

From City Planning.—Regional or metropolitan planning is the cooperative solving of problems common to the various municipalities within a given unit economic area. Any service or feature that can be made and should be used by only one municipality should not be considered in regional planning unless its location or character is detrimental to the region or to some other community.

Regional planning usually differs from city planning in the relative area of ground covered. In a city like Worcester, Mass., for example, where the built-up area is completely surrounded by a wide belt of farming land within the corporate limits of the city, with nothing but farm land in the adjoining towns, regional planning is reduced to a matter of being sure that the thoroughfares, transit lines, bus lines and railroads leading in and out of the city are effectively located and that they can be adjusted to take care of future growth without waste.

In other cities of exceptionally large area in proportion to their population, like Los Angeles with its 350 square miles, or even Cincinnati with its 72 square miles, or Baltimore, the city plan covers most of the contributory area which on the other hand would have to be covered by a regional plan in the case of a relatively smaller sized city, such as Boston, New Haven or Pittsburgh.

This contributory area goes to the limits of the commuting belt and includes all those communities which are daily dependent on the central city for their livelihood, social life or for the supply of commodities. In Buffalo, Boston, St. Louis and Cleveland this area has a radius of 20 to 25 miles; in New York the radius is 40 to 50 miles; in New Haven, Norfolk and Omaha the radius is about 15 miles.

Zoning.—In cities like Cleveland, Boston, New Haven or Philadelphia, each relatively small in area, with a large number of well-developed suburban or satellite municipalities immediately adjacent, certain problems of regional or metropolitan planning become quite serious. For example, a number of the cities and towns around Cleveland have been adopting stringent building zone ordinances which often exclude all industry and severely limit the spread of business. In other words, they have zoned against the city of Cleveland which will thus be obliged to provide common, economic facilities for the surrounding communities. The 40-odd municipalities around New York City that have adopted zoning ordinances have each naturally framed them to protect their own local interests, although perhaps unintentionally doing harm to other communities and to the region as a whole. It is in recognition of this fact, that Milwaukee is attempting county zoning and that the new Nassau County (Long Island) charter includes county zoning and city planning. However, unless the county includes within its limits the whole metropolitan area, a Metropolitan Planning Commission should zone the whole area as a part of a comprehensive plan and then insist that each included municipality should adopt the part of the plan within its limits and that the counties adopt the rest.

Building Codes.—Building codes have been generally adopted by the smaller municipalities surrounding large cities, but no two are alike. Some are far more stringent than others. The result is an unwarranted confusion which tends to waste and often seriously affects the orderly expansion of housing facilities throughout the area. There are now many features of building construction that have become standardized in practice. These should be consolidated in State codes. The other features of building codes which should be drafted by each municipality to meet its peculiar local conditions should be approved by the Metropolitan Planning Commission in so far as they may affect surrounding communities.

Subdivisions.—Each city and town grows by the accretion of subdivision plats. As the land within the corporate limits of the central municipality is more and more developed these plats extend into the territory beyond. Already some States, such as Ohio, New York and Virginia, have recognized how necessary it is that the city should control the layout of these plats from three to even fifteen miles beyond the city limits. The reason for this control lies in the fact that as the city grows the problem of getting in and out of the city by means of radiating thoroughfares becomes more and more serious. Unrestricted subdivision platting often renders impossible the cutting through of new traffic ways. However, these plats can be so laid out that they will

fit in with the development of a system of thoroughfares that will satisfy the needs of the region for a great many years to come and so that it will never be necessary to plow thoroughfares ruthlessly across existing built-up subdivisions. On the other hand it is unfair for the central city to impose its plan on the surrounding communities without their sanction.

The Cleveland Metropolitan Platting Commission, authorized by the State Law, points the way. It was to consist of official delegates from each municipality in the metropolitan area whose common platting of highways and control of all plats was to have been supported by pro rata assessment. The creation of such commissions is of the greatest importance, but to avoid overlapping such commissions should be merged in the more inclusive Metropolitan Planning Commissions.

Thoroughfares.—The federal, state and county highway systems now current throughout the country, are going far to solve the rapidly growing problems of intercommunication between municipalities. However, within most metropolitan areas such control is inadequate. The result is a series of tortuous and often much too narrow traffic ways leading in and out of the city and from one suburban center to another. A Metropolitan Interurban Planning Commission could plan to meet this situation as did the Newark Conference on Interurban Improvements, each local city or town engineer contributing his time as needed. The cost of execution of the metropolitan highway system should be prorated over the area as is the metropolitan sewer, water or park system about Boston.

Traffic Regulation.—Traffic regulations in the various cities and towns are often widely different from one another. This is extremely confusing to the through motorist. Therefore, it is desirable that uniform regulations should be worked out for a whole area similar to those now being worked out for the State of Ohio by a Committee recently appointed by the State Legislature. Standardized national regulation should be the ultimate goal.

Parking Control.—The control of automobile parking is likewise a regional planning problem in so far as those driving from one town to another on business or pleasure have difficulty in finding a place to park their cars. On the other hand the encumbrance of main traffic ways by local parking often retards through travel, and to the extent that it does should be controlled by the Regional Planning Commission.

Bridges and Viaducts.—Locating bridges and viaducts is a regional planning problem in so far as they facilitate intercommunication between municipalities, especially where they cross, as they often do, the border line between two communities. In such cases their location and the layout of their approaches should be determined as a part of the regional plan.

Interurban Trolleys and Busses.—Interurban transit lines and bus lines present distinctly regional planning problems because they often provide the chief means of intercommunication between communities or between the suburbs and the city. The long distances that have to be traversed in going from the central city to the outlying communities often necessitate the provision of rapid transit facilities, such as the Hudson tubes or the Boston elevated system, which take large numbers of commuters quickly from the city to an outlying distributing point, from which they continue to their destination by trolley or bus. Where trolleys or busses follow a main traffic way and especially where both are running in competition on the same street they often congest through traffic. These are all problems that can only be solved regionally, as is also the fixing of fare zones, for it is just as logical that trolley and bus fares should vary with the length of ride as it is for steam railroad fares.

Railroads.—Obviously the location of railroads and of their passenger and freight stations and yards is a regional planning problem, for they should make it easy for the commuter to get back and forth to town and for commodities to be delivered locally. At the same time the railroad rights of way and yards should be so located as not to interfere with the reasonable growth of the individual communities through which they pass. They should not be allowed to create "Chinese walls." They present, too, a serious problem where they cross thoroughfares, for it is obvious that all grade crossings should be eliminated where there is any considerable

density of traffic on either the railroads or the thoroughfares. Smoke is a problem, especially in suburban residential communities and therefore the electrification of the railroads where they pass through such towns becomes a regional planning matter. Again, it is evident that freight approaching or leaving the city should cause as little congestion as possible. This often suggests the provision of belt lines or intercommunicating lines so that through trains can be sent around the city instead of across it and so that freight cars can be spotted on the siding or yard nearest to the consumer. This again means careful planning by a Metropolitan Commission working in harmony with the railroad companies and at the same time coordinating these studies with the rest of the plan.

Waterways.—If the metropolitan area is situated on the ocean or on a navigable lake or river the waterfront tracts best suited to commercial and industrial use should manifestly be developed for that purpose regardless of the arbitrary corporate limits of any individual municipalities. This can be done only by a regional Port Authority as in the case of Portland, Ore., New York or London, but unlike these cases such plans should form an integral part of a comprehensive metropolitan plan. This should include a study of the accessibility of these waterfronts by truck and by rail and the reclamation of marshes and bottom lands.

Aviation.—With the growing use of aeroplanes, provision must be made nearer the larger cities for adequate landing fields easily accessible from the central city. From the standpoint of topography there are usually a limited number of tracts that are suitable. Therefore, as a part of a regional plan such possible fields should be preserved for aviation use and the thoroughfare system should be connected with them for ease of access.

Sanitation.—The more communities are grouped the more difficult it is for each separate municipality to provide its own water supply and sewerage and refuse disposal. Stream pollution becomes more and more of a menace. The only alternative is a co-operative development of common facilities such as has been worked out by the Metropolitan District Commission, about Boston or by the Cuyahoga County Sanitary Commission about Cleveland. The choice of areas to be used for water supply, or sewerage or refuse disposal, obviously must be made regardless of the limits of the individual towns, if the problem is going to be solved in the interest of the whole area. Therefore, again regional planning and State or County control is necessary.

Superpower Lines.—The consideration of superpower lines is becoming more and more a feature of our modern economic development. They, too, have to be located with the sanction of a Regional Commission in the interest of the whole area and often contrary to the individual interest of a particular community.

Parks.—Parks and playgrounds should be provided by each individual town for the use of its own inhabitants, but with the rapid growth of suburban areas it often becomes impossible for a particular community to find adequate space for recreation within its own borders. At the same time in other nearby communities there are often large tracts on steep hillsides, along brooks, around ponds or in swampy bottom lands, perhaps with beautiful outlooks or exceptionally attractive by Nature, which, on account of their topography or dampness, are impracticable for building development, but which nevertheless, would make ideal sites for parks or reservations. * * *

Reservations.—There are also botanical and zoological gardens, wild flower, tree or game preserves, amusement parks and camping sites and also cemeteries and the larger welfare institutions, most of which it is often difficult for each separate municipality to supply for its own residents, but which can be readily supplied for the whole metropolitan area if planned jointly. The same is true of golf courses, athletic fields and race tracks. The location and shape of all of these reservations affect regional development, for unless great care is taken in making the regional plan they are liable, by their bulk, to block the normal development of their district, especially if they are grouped in a thick belt as in the southwestern part of Worcester. These problems are especially worthy of consideration by a Metropolitan Planning Commission and while under our present laws it can have little legal control over them it can, through a citizens' committee, often exercise effective moral persuasion.

Public Buildings.—The schools in many outlying rural or often in suburban districts, especially the higher schools, could be combined so that one more efficient plant could serve several communities, as is the current practice in rural Ohio. In a group of smaller communities there are many other types of buildings that could be used in common with a considerable saving to each community. For example, auditoriums and exhibition halls, welfare buildings and hospitals and charitable institutions could possibly be built cooperatively or perhaps by the county. Even public markets and neighborhood centers can often be so located in a regional plan as to serve effectively a group of communities. Again, this implies the guidance of a far-seeing Regional Commission.

The Comprehensive Regional Plan.—None of the above listed features of a regional plan can be studied separately any more than they can in a city or town plan. They are all interdependent. There must be a constant interplay and give and take in studying them. Even from the beginning they should all be studied together as integral parts of the comprehensive plan so that it can grow as one unit and overlapping be avoided.

Principles of Regional Planning—Decentralization.—The most obvious fundamental principle of regional planning is the provision of adequate circulation in and out of and about the city, and second the planning for a normal and desirable growth of the city into the surrounding area. However, the real function of regional planning goes much deeper than this. The planner asks himself if our great agglomerations are really desirable; whether or not it wouldn't be better to retard the intensive growth of our larger cities and force them to spread out or to decentralize.

English town planners have come to believe that no city group should be larger than 30,000 to 50,000 people. German town planners have long been of the opinion that 75,000 to 100,000 people is the maximum, practicable size of a city. In France there seems to be much the same feeling. In America there has been no conscious attempt to limit the size of cities, but it is coming to be felt by many who are studying the problem that when an American city exceeds 100,000 to 150,000 inhabitants the economic and social disadvantages tend to exceed the advantages of concentration. They believe that the excessive cost of counteracting the evils of congested streets, transit, railroads, waterways, parks, tenements, schools, places of work and public services, outweighs any gains there may be in being nearer a choice of livelihood, a large labor market, a large clientele, or exceptional facilities in the way of schools, recreation or welfare services.

In England remarkably interesting experiments in decentralization have been conducted in the two garden cities of Letchworth and Welwyn. In the first of these the ultimate population is limited to 30,000 and in the second to 50,000, and in each case growth beyond that amount is prevented by restrictions on the number of families per acre and by the creation, in perpetuity, by covenant of agricultural belts around the eventual built-up portions of the town. Letchworth is self-contained economically and socially, while Welwyn is near enough to London so that part of the population commutes. Both are proving highly successful in practice.

Various regional plans for English and continental cities provide for moulding the future growth of the metropolitan area in a series of units of not over 50,000 to 100,000 inhabitants, each separated from the others by permanent agricultural and park belts and all connected with the hub by rapid transit.

Several interesting American schemes for regional decentralization have been worked out, notably the recent regional planning theory developed by Mr. Arthur Comey. Mr. Harland Bartholomew has, in his study of "The Load on the Land," arrived at desirable standards of population distribution. Until something better can be evolved they can well serve as standards for the decentralization of population.

Decentralizing Industry.—As long as the great majority of the inhabitants of a metropolitan area continue to earn their livelihood in the central city, decentralization will be difficult, if not impossible. Obviously the means of livelihood must first be decentralized as at Letchworth. This means that industry and wholesale business must be legislated or pushed or encouraged to move out into the suburbs. Fortunately, there is throughout the country a marked tendency in this direction. However,

it is a well-known fact that the majority of workers, in many if not most, of the larger industrial plants that have moved out into the suburbs are still living in the heart of the city and daily spending much time and energy in commuting back and forth. * * *

Investigation would seem to show that some of the chief reasons why the workers will not move out to the neighborhood of the outlying industrial plants is because it is difficult to find desirable, cheap housing in the vicinity. Then, too, school facilities are apt to be poor, churches and sect groups, theatres, billiard parlors and other leisure time employments are lacking or inadequate; it is difficult for their friends or compatriots to get in and out to see them and if the worker loses his job he has to pull up stakes and move to some other part of the metropolitan area where he can get work. On the other hand, the great development of the "movie," the "radio," the talking machine and the cheap automobile have facilitated decentralization.

The manufacturer, the wholesaler, and those who maintain general offices find that they have more to gain than they have to lose by being near the "center of things." On the other hand the rapidly increasing use of the motor truck is making it much easier to transport to and from the suburbs all commodities except the bulkiest. At best it is going to be no easy matter to attract even a small part of them to move out and even if they do, the endeavor must be repeated with the workers. In any case it is a legitimate function of regional planning to see if there is not some way of satisfying these various demands and at the same time finding a way of encouraging industries and general businesses to move out.

Eliminating Guess Work from Regional Planning.—It is easy enough to give a horseback judgment upon these intricate problems, but if their solution is going to be convincing, guess work must be reduced to a minimum and solutions be based on logical deduction from the facts. This means that a searching, quantitative study should be made of all the contributory factors. Then every possible solution, one after another, should be tried out and tested by the facts until almost automatically the one most effective solution stands out.

Effect of Topography.—For example, what is the effect of topography in the location of industry and business? Quantitative tests in a number of eastern cities show that heavy industries will rarely locate on a slope of more than two or three per cent. Lighter industries will locate according to their character on slopes up to seven and eight per cent, but rarely more except where there is exceptional water power. Industries requiring heavy machinery or many stories will not locate on filled land unless it be the only land available where they can rail sidings.

Similar tests show that business will rarely locate on a slope greater than seven per cent, while residences will locate on almost any slope up to 15 to 18 per cent and sometimes even up to 25 per cent provided there is quick and easy access to thoroughfares and transit facilities.

Industrial Area Per Worker.—Other tests in a number of cities show that the square feet of ground area per worker in industrial area varies from about 30 in the Manhattan loft districts and 50 in the textile and shoe mills of Massachusetts, up to about 1,500 sq. ft. per worker in the varied and rather opened industry of Elizabeth, N. J., and up to a maximum of about 4,000 sq. ft. per worker in the heavy open industrial districts of the Newark meadows. The cost of land varies roughly in inverse ratio to the above areas per worker.

These figures give some definite units and standards to use in the distribution of regional industrial areas. They already give a rough idea of how large and how far apart, and in what locations such industrial districts could and should be placed.

Laws of Growth.—A study of the laws of growth of a great many agglomerations make it possible to predict, other things being equal, to what extent and about how fast a community or area should grow. Every existing community is gound eventually to approach a saturated population. A further study of the laws of growth shows how this situation can be controlled or modified by intelligent planning. Therefore it becomes feasible as a part of a regional plan to determine approximately the eventual possible and the controlled destiny of population within each part of the metropolitan area at any given date. This is accomplished in practice by making a "Spot Map" with not over

25 people per dot for 1920, 1900, and often for 1910 to show in detail past tendencies in distribution and rate of growth. Then on a basis of tentative zoning, circulation and park studies the calculated population for about 25 years hence is distributed on the same map by adding a different kind of dots and crossing out 1920 dots where there must be decreases. With this map in hand it is easy by the simple method of counting the dots present and future within any given area to determine quantitatively, the approximate location and size and date of undertaking of almost every feature of the city and regional plan. Thus it is also possible to determine fairly closely a complete program and budget of execution over a long period of years.

Tenement Area.—Other investigations show that there is little economic or social reason why more than 12 per cent of the population of any district should live in houses containing more than two families. The "Load on the Land" studies show the lot area per family that should be allowed for given land values. Realizing that the majority of tenement dwellers work in industrial plants, these facts indicate approximately the amount of tenement area which regional zoning should provide about suburban industrial plants.

Business Area Per Inhabitant.—Investigation in a number of cities shows that the number of inhabitants per store averaging 25 ft. frontage varies from about 60 persons to 150. The United Department of Commerce shows 27 families per store average throughout the country, while investigations in the suburban communities around New York show an average of about 100 people per store. These facts again give a fairly definite basis for properly distributing and providing sufficiently large business areas to take care of the determined future growth of any given district, particularly when coupled with the fact shown by investigation that the great majority of people ordinarily will not walk more than a half mile to a store. This distance tends to decrease with the increase of density in population.

Farm Area Per Inhabitant.—An analysis of the statistics of the Department of Agriculture indicates that to supply all of the food that one man eats in a year six acres of farming land are needed. For a city of 100,000 inhabitants this would mean an encircling farm belt 18 mi. in radius from the center of the city or for a city of 1,000,000 inhabitants a farm belt 60 mi. in radius would be needed. Of course, in practice these belts are vastly smaller as most of our foodstuffs must come from elsewhere.

Further Data and Methods.—At the National City Planning Conference, held in Springfield last year, Mr. E. P. Goodrich brought out a number of facts, proved by experiment, which showed the relation of street traffic and transit to the size of a community, to the distance from the center of a community, to the distances between communities of various sizes, and which also showed the relation of population and to the character and use of property, street and transit facilities, etc. The many laws deduced from these investigations are fully as applicable to regional planning as they are to city or town planning.

Similar investigations have been and are being made by Mr. Goodrich and others with regard to every phase of city and regional planning. In other words, everything that affects the economic and social life of a community and its growth is being probed so as to reduce guess work to a minimum and to bring definiteness into regional as well as city planning.

Executing and Financing the Regional Plan.—Where original planning by annexation was feasible as in Baltimore, Norfolk or Cincinnati, the execution of the plan is relatively simple. It is simply an enlarged city plan. However, in the case of the majority of cities this is hardly practicable. A review of regional planning progress shows that there are several methods now being used of effecting the regional plan:

First; there is city and county consolidation which, unfortunately, has been recently defeated in Alameda County in California, but which is authorized in the State of Montana. This is really a modified form of annexation.

Second; there is the creation of a Metropolitan Planning Commission, such as was created and then disbanded about Philadelphia, which was just on the point of functioning in the case of Cleveland until a change of administration in the city delayed its work, and the Regional or County Planning Commission such as is now

being formed about Boston, Pittsburgh and Milwaukee.

Third; there is the creation of an unofficial Citizens' Regional Plan Committee such as is being formed in Buffalo and Chicago.

Fourth; there is the Foundation Plan such as is being made for the New York metropolitan area by the Russell Sage Foundation.

Each of these methods has its good and bad features. Obviously, where annexation is practicable it is the easiest solution of the problem, but in most of our large cities even a suggestion of annexation immediately puts the surrounding communities on the defensive. They are afraid of being swallowed up by the central city.

The official Regional Planning Commission method used in Philadelphia was declared unconstitutional. In any case, in each particular State the courts must decide whether it is constitutional for communities to transfer part of their legislative and taxing powers to a body which they can not control. If it is not constitutional then an attempt should be made to raise the necessary funds by private subscription.

The Sage Foundation method, while likely the only one feasible in an aggregation as huge and unwieldy as New York, is too arbitrary for general acceptance in much smaller cities.

Probably the best method of all, at least for the first stages of regional planning, is the creation of a Citizens' Regional Plan Committee consisting of representatives of the leading civic and economic organizations from each of the communities within the region. It would be the duty of such a Citizens' Committee to make a reconnaissance survey of the whole situation and perhaps to prepare tentative general regional plans as a demonstration and in any case to work up public sentiment to the point where these plans can be officially undertaken in detail and carried into effect by an official Metropolitan, Regional or County Planning Commission representative of all the communities affected. A permanent Citizens' Committee constantly co-operating with the official Commission would act as its interpreter to the public and at the same time serve as a watch dog over it to assure the continuity and stability of its plans.

This means a great deal of publicity and educational work among the surrounding communities and the enlisting of financial support by voluntary contributions or by levying a pro rata contribution on local civic or improvement associations. The experience of Buffalo, Chicago, Los Angeles and Boston in thus securing enthusiastic regional co-operation is good evidence of the effectiveness of this method.

The cost of executing each improvement that affects more than one municipality should be pro-rated among the units benefited according to methods sanctioned by many court decisions. These units would almost always include the central city as the principal benefitter and often a county, as well as various suburban municipalities. In practice assessments are prorated according to the population, the area, or the valuation of each municipality or according to its ability to pay or the frontage benefited or any combination of the above. The payment of these assessments can often be spread over the life of the improvement where earlier payment would cause undue hardship.

Needed Legislation.—No State has yet granted to a Metropolitan, Regional or County Commission all of the powers above outlined as essential to its proper functioning. The nearest approach was the Pennsylvania Act of 1913 which was declared unconstitutional. The Regional or Metropolitan Planning Commission bills now before the Ohio and Massachusetts legislatures are excellent models except that the Massachusetts bill does not provide for metropolitan control of zoning, building codes, private reservations and subdivisions. The Ohio bill is virtually complete in all its essentials.

Summary.—We are confronted by one of the most serious problems of the age: What shall we do with our ungainly metropolitan groups? The problem can not be solved except by intensive scientific study of all of the factors involved. There should be an appropriately constituted Regional Planning Commission aided by a Citizens' Regional Plan Committee constantly planning improved development of the area and fostering the execution of the plans as needed. We must make a united effort to counteract the sordidness and the social and economic ills of our larger city groups.

How to Avoid Waste of Explosives

Method of Reducing Quarry Blasting Costs Described in the Explosives Engineer

By R. N. VAN WINKLE,
General Manager, Hawkeye Quarries Co.

While quarries in the United States consume a large percentage of the high explosives manufactured for commercial purposes, there is much seemingly wilful waste of high explosives in the industry. Honest consideration is now being given by some companies to the highly important subject of how to avoid this waste.

Blasting Cost Next in Importance to Labor Cost.—In limestone quarrying, with which this article deals, the item of dynamite or blasting cost is next in importance to the item of labor, and at times it is even questionable in the mind of the writer whether or not blasting cost in the average crushed stone quarry operation does not supersede in importance the item of labor cost. Blasting is, therefore, the basic operation which governs labor and various other operating costs. Improperly blasted stone means not only wasted dynamite but increased secondary blasting expense, increased drilling and labor costs, curtailment of production, and the loss of organization morale; the latter is something which is too often ignored. Good blasting practice and results are fundamental to the successful operation of every quarry.

It is a simple matter to criticize and find fault, but what we in the crushed stone industry need badly, is more serious, unbiased, constructive advice and criticism of our blasting problems together with simple, scientific but non-technical solutions of our difficulties. It is unreasonable to believe that any of us who are quarrymen have the time, if the inclination, to go into the technical phase of blasting or the use of high explosives and even if we did we would soon find out that the information and reference books pertaining to quarry blasting are very meager. The writer speaks from experience, as he was foolish enough to try it, just once.

How Information on Blasting Can Be Obtained.—A fund of very valuable information for your guidance, however, can be gathered from the reading and studying of articles written in magazines and trade journals on this most highly important phase of quarrying. The writer not only recommends reading and studying such articles, tables, etc.; he cuts them out and files them in a loose-leaf book for constant reference.

There was a time in the crushed stone and quarry industry when it was not so important to watch blasting costs, for a little dynamite wasted was not a serious matter. That was in the "Good Old Days" when dynamite was selling around 10 cts. a pound; but now it is a quite different story. Blasting is one of your heaviest expenses; so give it the attention and thought it is entitled to.

Prices of explosives and blasting supplies are uniform; that is to say, you get about the same price regardless of which manufacturer quotes you, so the manufacturers can no longer expect to obtain orders on just a competitive or price basis, but must get their orders on quality of explosives and supplies offered, coupled with the service they are willing to render to the customer. Personally the writer feels that this service when properly rendered by the explosives manufacturer is of great assistance to the quarry operator. The manufacturer who is not ready and willing to give service is making a serious mistake, because while blasting is just one operation—although a highly important one—of the many the quarryman has to deal with, it is the heart of the manufacturer's business.

After all, service is the keynote of present day business and if a man is getting service and results, price is almost a secondary consideration. It is a rare thing to hear a man in a hotel or cafe complain about the price of a meal that tickles his palate and has been properly served; neither do you hear a quarryman kick about the price of explosives if he is getting results and making money.

Educating the Men in Handling Explosives.—Too much gamble and guess has been practiced in the use of explosives in quarrying operations and the direct cause of this can be laid, the writer feels, at the door of the

quarry executive, who ought to get out once in a while and visit with his men, or, better still, live with them and while so doing, educate those who handle explosives. This is a simple method which has been tried out in our own operations and is worthy of consideration as a method to discourage waste of explosives.

Educate your men in handling dynamite; teach them to think not in pounds of dynamite, number of caps or electric exploders, feet of fuse or Cordeau, but in dollars and cents. Take a little time some day and assemble all the men, from the superintendent down, who handle or use explosives and blasting supplies. Have a cartridge of every size explosive you use, a piece of fuse a foot long, a piece of Cordeau a foot long, one of each size blasting caps, and an electric exploder with the length wire most commonly used. Talk to them like a "Dutch Uncle"; explain to them that this one cartridge of 1¼ in. by 8 in. of special ammonia dynamite you are showing them is worth 7 cts; that this cartridge of 40 per cent 5x10 straight nitroglycerin dynamite is worth $1.47. Tell them that this small, insignificant little No. 6 copper blasting cap that you have in your hand costs 1½ cts., while just 1 ft. of fuse they are so generous in using costs 1 ct.; that 1 ft. of Cordeau costs you 5 cts.; that a No. 8 copper wire electric cap with 30-ft. wires is worth 18½ cts. These men have their hands deeper in your pocketbook than anyone around your operations, so teach them the value of explosives and supplies and encourage them to think in dollars and cents instead of pounds, feet, and number of caps and exploders and you will find a wonderful improvement in your blasting costs and dynamite and blasting supply consumption.

Teaching Them to Think in Terms of Dollars and Cents.—The writer is a constant and firm believer in educating workmen, not only to think in terms of dollars and cents as far as explosives are concerned, but to teach the more apt employes how to figure tonnages in blank shots, how to figure explosives required per foot of drill hole, tons of stone per foot of drill hole in shots, hole spacings, etc.

When your powder monkey, or shooter, is of foreign extraction and unschooled, as is often the case, you can reach him with the dollar and cents idea, but where large shots are put off the writer makes it a practice to relieve the quarry superintendent from all other duties, and requires that he actually supervise all large shots; for after all the superintendent is the man most interested, as he is strictly accountable for final results and, therefore, must be in authority. Bank shots in our operations are platted on paper, depths of holes accurately measured, toe considered, and burden and spacing are checked. Then the superintendent comes in with this data and, with some other member of our organization, figures out the loadings for each of the holes which have been previously numbered on the plat or drawing.

Educating employes will surprise even the most skeptical employer, and if you can get men to thinking they need not expect promotion until they have made others to fill their places, you will soon be getting full value for your labor payroll.

Municipal Bus Lines

Salient Facts of Public Bus Operation in Five Cities Outlined in The Toledo City Journal of August 11

Most of the municipally-owned bus lines now operated in this country, are primarily for the purpose of transporting people to the large city parks.

Small municipal park bus lines are operated in Detroit, San Francisco, Los Angeles and St. Louis. New York City with its 27 city bus lines is the only outstanding example of a municipal bus system on a large scale.

Other cities, notably Buffalo and Milwaukee, are now seriously considering the matter of starting city bus lines but nothing concrete has been done.

The above cities were queried by the Toledo Commission of Publicity and Efficiency because of the discussion in the Toledo city council relative to starting city bus lines to fill the transportation needs set out in the transit survey.

Comprehensive information was received from all of the above cities with the exception of New York which will be obtained soon. With the exception of New York City, the beforementioned city bus systems are mere-

ly a matter of convenience for the citizens to assist them in getting to the parks. For this reason the matter of revenues has not been considered absolutely essential. Only one, that in Los Angeles with a 10 cent fare, can be fairly considered self-supporting.

These city bus lines were started as follows: Detroit, 1911; San Francisco, 1917; Los Angeles, 1920; St. Louis, 1916 and New York City, 1919.

Most Routes Are Short.—All of these lines with the exception of that in San Francisco and New York City, operate only one route. San Francisco has two and New York 27 lines. The length of the routes are as follows: Detroit, 1.5 miles; San Francisco, 2:08 and 4.25 miles; Los Angeles, 7 miles; St. Louis, 5 miles and New York (1920) 25 miles.

The number of busses are as follows: Detroit, 10 busses; San Francisco, 5; Los Angeles, 5; St. Louis, 5 and New York City in 1920, 170 busses.

All the cities except New York which is not reported, financed the purchase of the original busses by an appropriation.

Nickel Fare Is Rule.—The "nickel" fare is the rule, mainly for the reason that the lines are not supposed to be revenue producers. Five cents is charged in Detroit, San Francisco, St. Louis and New York (1920) while in Los Angeles the rate is 10 cents for adults and five cents for children with a 35 cent rate for the round trip of seven miles.

Last year the Detroit bus line of 10 machines operated under the park department, took in $81,538.83 in passenger revenue while the cost of operation including repairs and overhauling amounted to $80,237. Evidently nothing is set aside for depreciation or renewals.

Deficit in Frisco.—The revenues of the San Francisco bus line in 1922 totalled $38,900 while the operation expense was $68,000. No charge was made for superintendence or overhead. The transfers and school tickets at 2½ cents largely accounted for this deficit. A charge of $5,141 or $18 per cent of the receipts was set aside for depreciation. The net loss per day was $73.11.

The five Los Angeles municipal busses also under the park department, brought in sufficient revenue to pay operating charges and lay up a reserve of $5,000. But no charge is made for depreciation, Van Griffith, the motor bus commissioner, says. He asserts that even if ample depreciation were to be charged against the $5,000 reserve, there would be a balance.

The Commissioner of Public Affairs of Buffalo recently recommended that the city buy 50 to 100 double deck busses to operate between the public square and the different city parks.

A Milwaukee aldermanic committee is now considering the feasibility of operating municipal bus lines there.

N. Y. Has Large System.—New York City is the only large municipality which has had experience with a city-owned bus system on a big scale. Detailed information has not yet been received by the City Journal. By court order 27 city bus lines which serve about 250,000 people, were tied up recently. The city's right to operate busses was questioned. An attempt to call a special session of the legislature to give the city such power, is being made.

Grover Whalen, commissioner of plants and structures of New York City, under whom the busses are run, declared in an address at the Highway Transport Conference in 1920 that busses can be profitably operated on populous routes, at a 5 cent fare. The New York busses have been running since 1919. In 1920, the city operated 170 busses on 10 routes over 25 miles of public highways at a five cent fare.

Mr. Whalen pointed out that the use of a one-man bus as compared with a two-man trolley, results in greater economy.

Model System Suggested.—The Commissioner outlined a suggested motor bus system based on the experiences of his department; 100 busses with extra parts and garage equipment, $570,000; fixed charges for one year including liability insurance, depreciation and 220 employees, $635,000; 94 busses in operation and six in reserve; daily cost, fixed charges, $1,740, gasoline, oil and tires, $663 or a total of $2,423. 60,000 passengers daily at a five cent fare would bring in $3,000; daily profit of $376 or an annual profit of $137,000.

There may be a few other cities which operate city bus lines and as data on these is obtained, it will be turned over to the council sub-committee which now has this matter under consideration.

General Instructions for Surveys for Highway Pavements

The location of the center line of a highway pavement is a matter on which no two engineers would produce the same results. There is as much chance for differences as there would be in competitive designs for a building submitted by various architects.

It is realized that no set of suggestions, regulations or rules can be written that will apply to all problems of location as they present themselves to survey parties in the field. While the following instruction prepared by G. N. Lamb, District Engineer, Illinois Division of Highways are not intended to apply to all types of highway improvements, nor to conditions in all parts of the country they contain many points of interest to all engineers . The instructions are based on observations of topographical and other natural features, and of the requirements of modern traffic as applied to road conditions in northern Illinois, within a radius of 75 miles from the city of Chicago; surrounded, as it is, by densely populated suburban districts. The instructions are offered to enable field parties to work more nearly toward the same standard in the location surveys, and to insure more uniformity in the methods of securing and recording information necessary to the completion of road plans in accordance with the policies of the Bureau of Design of the Illinois Division of Highways.

Mr. Lamb's instructions follow:

Direction.—In general, surveys on a given section will proceed from west to east or from south to north. This will enable the maps and profiles to be platted so as to face north or west.

Bench Line.—Prior to making the transit survey a line of precise levels should be run and B. M.'s should be set at intervals not to exceed ¼ mile. The levels will be checked when cross-sections are taken but unless it is found that a distinct error has been made, the original B. M.'s will be accepted as correct. Benches should be selected with reference to permanency and convenience to the line. If possible avoid driving nails for B. M.'s in poles or posts; a nail driven into a tree or root is preferable. Benches should be so described in the notes that there can be no question of their identity for future work. All benches and turning points should be read and recorded to the nearest hundredth of a foot. Begin with a datum of 100, unless there is a possibility of a fall in the grade exceeding 100 ft.

The Transit Line.—Frequently the located line will follow the center line between highway fences, but the requirements of good alignment will often necessitate the acquisition of additional right-of-way and in many cases a radical relocation may be justified. On a long tangent it may be advisable to find tentative centers at frequent intervals along the line. From the center points thus found a tangent may be located that will be as near the average center as circumstances will permit, due consideration being given to any existing embankments, deep cuts, permanent bridges or drainage conditions. It is advisable to run to a foresight rather than to produce a long tangent by reversing the telescope or by turning angles of 180 degrees at convenient transit points. All angles should be read clockwise without reversing the telescope. Referenced hubs should be set on long tangents at intervals not to exceed ¼ mile.

The location of a paved highway presents diversified problems of appearance, the importance of which is apt to be greatly undervalued. The eye delights in straight lines or graceful curves; and conversely is annoyed by broken lines, unsightly kinks or ill-fitting curves. Tangents should present to the vision an unbroken aspect. If small angles or curves are unavoidable they should if possible be placed at major summits, or there should be a distinct object or obstruction to cut off from view that portion of the adjacent tangent beyond the angle or curve. Horizontal curves in alignment should be introduced only when there is a logical reason, aside from existing right-of-way fences to justify a change in direction of the center line.

The transit line will be the center line of construction and will be the basis of all measurements. The greatest skill and care should be exercised to see that the located center line, with respect to appearance as well as usefulness, will be the most consistent location possible. The selection should be such that there can be no excuse to tinker with the alignment during construction. Bear in mind that the old right-of-way was selected to serve traffic in the days of the ox-cart or

the horse drawn vehicle. The newly selected alignment will not only be the basis of a high priced improvement to serve intense modern traffic, but must stand subject to commendation or condemnation by both present and future generations—a monument to the skill or to the incompetence of the locating engineer. The selected center line should be so located as to serve for a pavement that perhaps may eventually be widened to two or more times the present contemplated width. The modern paved highway is worthy of its right-of-way.

Standards of Curvature.—The following standards of curvature should be observed, or if conditions will not permit compliance thereto, the District Engineer should be consulted before a decision is made:

Select the curve that will best fit the ground, giving preference to the longer curve. Avoid odd minute curves and select curves of even degree if possible. Avoid terminating a curve less than 100 ft. distant from a bridge. All curves having radii less than 1,000 ft. will be spiraled and widened. Run in all curves having a central angle exceeding one degree.

The use of the compound curve will often be advisable and in many cases will fit the right-of-way better than a simple curve. Curves may be compounded as many times as desirable. If a compound curve is employed, the lengths of the component curves may be decreased, provided the total length of compound curvature will be not less than the simple curvature indicated above. For reasons stated in the preceeding paragraph curves having radii less than 1,000 ft. should not be compounded with curves having radii 1,000 ft. or greater.

In many cases it will be advantageous to make a paper location from a topographical or contour map made previous to the location survey.

P. C. and P. T. hubs should be set by measuring off the calculated tangent distances from the P. I. The stationing should be carried around the curve; that is, the station number of the P. T. will be the station number of the P. C. plus the curve length. This method will eliminate the confusion of an equation of stations. Ordinarily cross-sections and all distances should be measured from the center line of curvature and not from the tangents.

The following curve data should be recorded in the notes:

(1) Stations and reference points of P. C.
(2) Station and reference points of P. I.
(3) Station and reference points of P. T.
(4) Central Angle.
(5) Degree of curvature.
(6) Length of tangents.
(7) Length of curve.
(8) Chord lengths used.
(9) Deflection angles used at each station.
(10) Magnetic and calculated bearings on the tangent from the P. T.

For reference points use a nail driven through a tin washer into a tree or root or into a stake driven to within ½ in. of the ground surface. The stake should be set near a post or other object easily described; it should be measured off in even feet and the nail should be set accurately within one-hundredth of a foot. Reference points should be so placed that they will not be disturbed during construction.

Chaining.—The accuracy of chaining should be in keeping with the high class improvement contemplated in the survey. All measurements of alignment should be made with the chain held truly horizontal, using the plumb-bob or "breaking chain" as occasion may require.

Stakes.—Temporary center stakes or markers will be set at every 100-ft. station; but more permanent stakes should be set along the fences at right angles to the center line. These stakes should be at intervals not to exceed 500 ft. on tangent, and 50 ft. to 100 ft. on curves.

Stakes placed at the side should bear the station number on the face, and the distance from the center line on the rear. If possible, the side

MINIMUM LENGTH OF RADII.

(1) Curves having an intersection angle exceeding 45° (Bond Issue Roads)	500 ft.
(2) Curves having an intersection angle exceeding 45° (Secondary Roads)	300 ft.
(3) Curves having an intersection angle of from 25° to 45°	1,000 ft.
(4) Curves having an intersection angle of from 5° to 25°	2,000 ft.
(a) Minimum length of curves	1,000 ft.
(b) Minimum distance between broken back curves	1,000 ft.
(c) Minimum distance between reversed curves	300 ft.

(a), (b) and (c) subject to modification under special conditions.

stakes should be at even feet and at uniform distances out.

On all relocations, a stake at each station should be set at the center line and driven to within 1 or 2 in. of the ground; also a reinforced hub-stake should be placed at each intersecting fence line. Every precaution should be taken to avoid leaving nails or stakes in the public highway in a manner to endanger rubber tires. The engineer in charge of the party must be held personally responsible for injuries from such causes.

Right-of-Way.—The names of all abutting property owners should be given. Measurements to right-of-way lines or fences should be taken at right angles to the center line at each station, or at closer intervals if necessary, to show all the angles or irregularities. The distances should be recorded in feet and tenths. All state, county, township or corporation lines and all sections and half section lines should be located and recorded, giving the station number at the intersection and the angle with the center line. When a section line is crossed, a measurement should be taken to the nearest section corner or quarter corner. All property lines adjacent to the highway should be shown with respect to location and direction. The notes should show the location of all intersecting or near-by streams, waterways, highways, bridges, culverts, tile lines, and public utilities; and all buildings, driveways, private entrances and field entrances, as well as polo lines, trees, hedges or shrubbery adjacent to the line. All information pertaining to right-of-way should be recorded in the transit notes.

Drainage.—The survey should determine how all water enters, crosses, travels along, or leaves the right-of-way. The direction of flow should be indicated by arrows. The meander of all streams or important ditches should be shown for a distance of 200 ft. each side of the center line. Sufficient levels should be taken to determine the direction of flow and the gradient of the stream and the elevations at the right-of-way lines and at the upstream and downstream ends of the present structure. Take levels along the ditch lines of intersecting roads, and indicate whether such ditches may be utilized to dispose of water from the right-of-way. All possible information regarding tile lines or tile inlets or outlets along the road should be noted. Note where all new drainage structures and all replacements of existing one will be necessary. If an existing culvert is to be replaced, note the width and height of the waterway of the old one and the elevation of the flow line. If an old culvert or bridge is to remain as a part of the new improvement, make a detailed sketch showing both plan and elevation in relation to the center line. The data for the larger culverts and for the bridges should be shown on the regular bridge inspection blank. The following data should be secured:

(1) Drainage area served.

(2) Nature of area drained (level, rolling or hilly).

(3) Size of opening of near-by structures serving the same stream.

(4) The amount of water flowing in normal times and the elevation and cross-section area of extreme high water.

(5) The nature and bearing qualities of the soil at the probable elevation of the bottom of the footings, and the possibilities of scour in the stream bed.

(6) Levels should be taken to show the true profile across the bed of the stream and the bank slopes.

Recommendations should be noted as to the required size of opening for the new structure. The county superintendent of highways, the local highway commissioner, and adjacent property owners should be consulted freely as an aid in deciding the size of waterways required. Note the location of all required entrance culverts and the necessary size. So far as possible, preference should be given to summit entrances rather than to culvert entrances.

Cross Sections. — Cross sections should be taken at each station at such plusses as may be necessary to show truly plain surfaces between readings. Readings should be taken for a width of 30 ft. each side of the center line, or in cases of deep cuts or fills they should be taken for a corresponding greater distance. Cross sections extending 100 ft. or more to the side should be taken at all intersecting roads and at private entrances.

The level notes should indicate any conditions that might restrict the depth or width of cut or fill for a given distance and the extent of such restriction; they should indicate any condition that might influence leaving out the standard side ditch, or the substitution of tile in place of surface drainage.

If borrow pits are required a center line should be established and well referenced. Cross sections should then be taken at right angles to this center line.

Data at Railroad Crossings.—A substantial hub driven flush with the ground should be set at the center line between rails, or between tracks; and referenced. The exact plus to the hub and to the gage line of all rails as well as the angle of the tracks should be recorded. If the tracks are on a curve, the angles to the center line at intervals of 50 ft. each direction for several hundred feet should be recorded. In case the highway is on a curve the angles should be read to the tangent to the curve at the intersection. The number of the nearest milepost and the distance thereto should be shown. In case of a contemplated grade separation there should be at least 150 ft. of tangent before starting a curve either side of the tracks.

Record in hundredths the elevation of the tops of all rails on the exact line of intersection and take top of rail levels for one or two thousand feet each side of the crossing. If possible, take a reading on one of the railroad B. M.'s and note the equation of levels. Record the length of cross-ties, the height of the steel rail and the distance to near-by switches or turnouts. Note all drainage conditions affecting a grade crossing or a grade separation.

The Field Book.—Number the pages of the field book. The first four pages should be reserved for keeping the time of the men employed and for cost data pertaining to the survey. Each day's work should be dated, the weather conditions noted, and the names of the men and their various duties recorded. Before the book is forwarded to the office, the cover should be lettered in ink as follows:

Route
or ..... Section..... County
Project
From .....to .....
Station .....to station.....

Forest Roads.—During the past 11 years the United States Department of Agriculture has spent $20,435,200 in the construction of 5,950 miles of roads and 8,960 miles of trails within or adjacent to the national forests. In addition, $7,446,000 of co-operative funds from States and counties was expended upon this construction.

The First City Manager

An Article in the July City Manager Magazine

By LOUIS BROWNLOW
City Manager, Petersburg, Va.; President City Managers' Association

When the council of the city of Stockton in California decided that they wanted a particular man for City Manager they wrote to him and asked him if he would consider taking the position and, if so, what salary he would require. The man replied, substantially, "Yes. $20,000." And then he forgot it.

But the council of the city of Stockton did not. They wanted that particular man. They responded, substantially, "O. K. Will expect you September 1."

Thereupon the man went to a meeting of his council and resigned. His council didn't want him to go. So they said, substantially, "We'll see the raise and make it $20,000 to stay."

But the man couldn't do that. He couldn't trade with a city that he had served so well. Another city had asked him to come to it and to name his own salary. Unexpectedly they had taken him at his word. His word was his first consideration.

Therefore on September 1, 1923, Charles Edward Ashburner will become City Manager of Stockton, California. The city council of Norfolk, Virginia, will choose some one else to take his place.

Mr. Ashburner is not a man who measures his work in terms of money, and neither do the other members of his profession. Yet it is interesting to everybody connected with the movement for the City Manager form of municipal government to note that Stockton, California, a city of less than fifty thousand inhabitants, is paying the largest salary ever paid to a City Manager. It is equally interesting to note that already Mr. Ashburner was the best paid man in the profession. His salary at Norfolk now is $14,000 a year, he having reduced it himself from $16,000, which amount he received last year.

More interesting than these things, however, is the fact that Charles E. Ashburner was the first City Manager.

Whatever may have been the exact

circumstances leading up to the momentous decision (for Ashburner is poor at autobiography and I have tried unsuccessfully to get the full details of the story out of him) the fact remains that the first city to select a City Manager and, therefore, to launch the city manager movement in America was the city of Staunton in the Old Dominion of Virginia, and that the man they selected was Charles E. Ashburner.

That was in 1908. After serving there for three years as City Manager he resigned to undertake some special engineering work for the American Railways of Philadelphia. On January 1, 1914, he again became a city manager, this time at Springfield, Ohio. There he remained until September, 1918, when he became City Manager of Norfolk, whence he will go at the end of a crowded, useful, successful five years.

Mr. Ashburner was the first City Manager. He was the first president of the City Managers' Association. He has been for some time and still is the highest paid City Manager in the country. He now goes to a small city which is willing to pay for his services as municipal executive a salary larger than ever before fixed for a municipal executive, although no larger a sum than hundreds of cities uncomplainingly have paid by processes of law to fee officers and by processes of corrupt politics to bosses.

In Norfolk, a great seaport of more than a hundred and fifty thousand people, under the administration of Mr. Ashburner, as much has been done in five years as could have been done in a quarter of a century under the old regime.

There is not the time, nor have I the space, to tell of what has been done in Norfolk. Its quality may be inferred from the fact that when the newspapers came out with the announcement of Br. Ashburner's resignation, most of the important civic bodies, through their boards of directors and, in at least one instance, general meetings, called on the city council to raise his salary and keep him. The council did its part and offered to raise the salary, but Mr. Ashburner had given his word to Stockton.

It is the time, however, to say something about Ashburner. He is a working whirlwind of a man who has a clever vision of the future of municipal government and the faith to count that vision among the realities of life. Sometimes, like other whirlwinds, he is tactless of phrase. Sometimes, like other seers, he is impatient with those who cannot see. Always, like other true believers, he wastes no time on those who have no faith.

It is his reward to be ranked first in accomplishment in that profession in which he ranked first in history.

Born in Bombay, India, in 1870, the son of a British army officer, he was educated in England, France and Germany. The chum of his school days was that Eric Geddes who, when the strain of the World War came, was to serve England as its supreme organizer of transport on land and sea.

He came early to the United States to seek his fortune, having nothing but a degree of civil engineer from Heidelberg. He found a minor job on the James River under the Army engineers.

It was not long, however, until his special talent for municipal engineering found its opportunity for manifestation, for in 1890, when he was only twenty years old, he was engaged by Major Lewis Ginter as engineer in charge of the development of Ginter Park, now an important part of the city of Richmond. He followed this interest in municipal engineering for years, as an engineer employed by railways and electric companies, as an independent contractor and as a consultant. In 1908 the decisive step was taken and he became City Manager of Staunton, the first of a new profession.

In Staunton, in Springfield and in Norfolk, the name Ashburner is wrought into the living history of the development of the community. So will it be, we are sure, in Stockton. And in the United States he will always be "the first City Manager."

Construction on Lincoln Highway in Nevada.—Construction work on a five-mile section of asphalt-paved Lincoln Highway has been started between Fallon, Nevada, and Grime's Ranch to the east. This new improvement will connect with the concrete paving on the Lincoln Highway through Fallon. The new pavement will be 15 ft. wide and surfaced with asphaltic macadam, one of the few sections of this type of improvement in Nevada.

Quality Standards in Commodity Production

Experiences of Portland Cement Industry in Their Setting Up Described in Paper Presented May 8 Before Fabricated Production Group, U. S. Chamber of Commerce

By F. W. KELLEY,
President, Portland Cement Association.

Quality and quantity standards are essential for the free interchange of commodities in commerce beyond the stage of first-hand transactions in which personal observation and opinion govern. Progress in civilization is measured by commerce, standards are at the base of civilization as well as of commerce.

Standards of time, space, weight, value and conduct are as old as history. They are so much a part of the environment into which each generation is born that there is no conscious recognition of a period when they did not exist, any more than in the case of the air we breathe. But all these standards had to be determined and established. Probably the first generally recognized minimum quality standard was that of conduct.

Every thinking man must recognize the necessity for standards and the desirability of providing recognized quality standards in almost every line of industry. There are in each industry, however, the practical questions —what should the standards be; how should they be determined; how can their acceptance be best accomplished?

There are at least twenty industries in which nation-wide quality standardization has been undertaken to a greater or less degree. The one with which I am most familiar is the portland cement industry, in which a quality standard for cement accepted throughout the United States was voluntarily established through the cooperation of a large number of public and private engineering and technical organizations concerned with the use of cement.

Each industry has its special conditions and special problems, but I believe the same principles apply to quality standardization in all industries, and that properly worked out, favorable results in them all will follow. The experience of the portland cement industry may therefore be useful to other industries, and I hope you will bear with me while I bring out a few facts which will show why a nation-wide standard was essential, and will make clear how it was established.

Portland Cement Industry.—Portland cement, as is well known, is a powder which when mixed with water and sand, broken stone, or other aggregate, gradually hardens and binds the mass together in a solid stone known as concrete.

Portland cement was discovered and patented in England 99 years ago. Its manufacture was carried on principally in England, France, and Germany until about 1872, when its production was begun in a small way in the United States. The average annual production in the United States in the '70s was about 9,000 bbls. It had grown to a little over 5,000,000 bbls. in 1892; to about 17,000,000 bbls. in 1902; and to nearly 115,000,000 bbls. in 1922. Estimates just made public by the U. S. Geological Survey give the estimated productive capacity of the United States as 146,500,000 bbls. annually.

The manufacture of cement is an exact chemical-mechanical process in which natural raw materials are ground and mixed; combined at a white heat to form a new artificial material called clinker, which is again ground to a finished product. The process is exactly controlled technically; uses large quantities of fuel and power; has large plant investment and slow capital turnover. Manufacturers must rely upon a large volume of business to make profits on this heavy commodity which is of limited shipping radius, and which sells at a pound price lower than any other highly manufactured article.

Portland cement when completely manufactured and ready for the consumer is, in its relation of usefulness to the community, a means and not an end. Its useful end is that of an essential ingredient in making concrete.

Concrete has a wide use because of its adaptability; of the ease with which it can be handled and formed into manifold structures; and of its

qualities of permanence, fireproofness and artistic appearance.

Cement, unlike many commodities, is not consumed. A concrete structure properly made has a permanent asset value. Full realization of this asset value, continued demand for cement, and the prosperity of the industry, depend upon right quality cement and right quality concrete.

Anybody anywhere may attempt to make concrete and the results reflect for all time the materials and methods used in the first few hours of its history. It is essential to all interests that the user of cement make good concrete.

Factors in Cement Industry.—The work of the Portland Cement Association, organized in 1902, which is a recognization of this mutuality of interest between cement user and manufacturer, is so closely bound up in the development of the industry that it must be here mentioned.

The Portland Cement Association is a national organization of cement manufacturers whose aim is to increase the knowledge, utility, and use of portland cement through scientific investigation, public education and national promotion.

It "sells" the use of cement, but not the commodity. Hence it is not concerned with prices nor other trading relations between its members and their customers.

It performs only such functions as cannot as well if all be performed by its members individually.

It undertakes only such activities as are for the common good and whose benefits when utilized flow alike to all contributing members.

Its conduct is jealously guarded and made to scrupulously conform in all respects to a high conception of commercial morality and a strict interpretation of the law.

It is much concerned with the quality of cement marketed by its members, since a poor quality cement furnished by any member would reflect upon the industry, decrease the use of cement, and hence injure every member.

The association has been especially concerned not only with right quality cement, but with learning how to use cement right, and with making this information universally known. It maintains a research laboratory and field forces for these special purposes. When it is realized that an apparently simple matter like the quantity of water used in mixing concrete may make the difference between good and bad results, the need for this service work may be appreciated.

Mention should also be made of the American Society for Testing Materials, organized in 1902 "for the Promotion of Knowledge of the Materials of Engineering and the Standardization of Specifications and the Methods of Testing."

Its members are both producers and consumers familiar with the matters covered. Specifications are formulated and adopted under carefully prepared rules or procedure insuring to the highest degree sound, unbiased results.

Important factors in the situation are the Bureau of Standards of the U. S. Department of Commerce, with its group of trained experts and extensive laboratory equipment, and the several engineering societies to be hereafter mentioned.

Development of Specifications.—With this background of conditions and factors affecting the industry we can now more intelligently trace the development of quality standards for cement.

In the early years when the industry in this country was small, its quality standards were imported. As the industry developed, the American Society of Civil Engineers undertook to formulate a uniform method of tests for cement, and from 1885 to 1903 this was considered the most reliable guide to a proper method of procedure.

In this period many engineers and architects seemed to feel, perhaps to avoid reflection upon their professional skill and progressiveness, that it was necessary to add to an old cement specification some new requirement on each new job. A compilation of 91 cement specifications made in 1898 by Mr. R. W. Lesley, who later became first president of the Portland Cement Association, showed that scarcely two were alike. In many cases, the specification requirements were contradictory, and if strictly followed, would sometimes impair the quality of the cement. The result was endless annoyance, confusion, delay, and difficulty for the consumer and manufacturer alike. A standard specification was becoming a necessity.

The American Society for Testing Materials took the lead in supplementing the investigations of the Ameri-

can Society of Civil Engineers and in 1904 the first American Society for Testing Materials specification for cement was adopted. The American Railway Engineering Association, American Institute of Architects, the United States Bureau of Standards, the U. S. Government Engineers, and the Portland Cement Association, as well as the American Society for Testing Materials and the American Society of Civil Engineers, continued to study and to modify cement specifications and methods of tests sometimes within their respective organizations, and sometimes through joint committees.

The method of the American Society for Testing Materials was unique in that its committee on cement specifications represented engineers, architects and other consumers who were always a majority, as well as producers, who were always a minority. This brought to bear upon the specification requirements a knowledge not only of the needs but also of the possibilities. Specifications made under these conditions are much more apt to be well balanced and useful than if made from one point of view only.

Adoption of Specifications.—The final revision of the cement specification was unique also, because its requirements were subject to the most careful laboratory research and checked with experience in the field. The substitution of the facts of research, for unsupported opinion, had its logical effect in reconciling views of men with engineering training. A single standard cement specification became an accomplished fact and was recognized by all established organizations in the United States in 1921. This was adopted on March 31, 1922, by the American Engineering Standards Committee as its Specification Number One.

As the standard cement specifications were developed, much work was required to secure their general use. Engineers who for 20 years had been active in the engineering societies which formulated and later adopted the specifications, readily accepted them. Others not as familiar with the progress made, continued to use their own specifications until the mass of data and authority back of the standard specification was brought to their attention, when they generally were glad to join in establishing a single standard, the advantage of which they at once recognized.

Neither did all producers at once take up the specifications as developed. In the early days of the industry, blended and adulterated cements were sold under many brands. Membership in the Portland Cement Association was later open only to those making true portland cement.

Producers in some cases were reluctant to give up making cement to conform to certain special specifications because of a supposed advantage in marketing thus obtained by them.

The research work and tests made in establishing the standard specifications showed, however, that the existing variations from the standard were without economic value to the consumer. The general adoption of the standard specification by the engineer and consumer decreased the demand for cement made to special specifications, but it should be accounted a credit to these producers that they were willing to cut out the "bunk" so frequently used in selling, and provided a product having known and tried qualities and value.

On June 28, 1922, the Portland Cement Association, representing a large part of the manufacturers of portland cement in the United States, adopted a by-law making membership in the association contingent upon members' product meeting the requirements of the standard specification.

Features of Specifications.—At the present time the standard specification for cement is almost universally used in this country. Thus we now have a nation-wide quality standard for portland cement voluntarily accepted by both consumers and producers. It is the highest standard for cement in the world and has had an important effect in promoting, extending, and improving the use of a concrete in this country.

When compared with earlier specifications it is particularly noticeable that the fineness of cement is now measured with a sieve having 40,000 openings per square inch, a weave so fine it will hold water; instead of with relatively coarse sieves which have now been discarded.

The strength requirements are nearly double those of early specifications and are determined by improved methods.

The standard cement specifications establish in most essential particulars minimum requirements, thus encour-

aging improvement. A quality standard must be responsive to changes demanded by new conditions in use or in production.

The Cement Committee of the American Society for Testing Materials is charged with the duty of studying proposed improvements in the cement specifications. Each suggestion is carefully tested and weighed, for in a material of such fundamental importance there must be certainty that changes are improvements. Laboratory practice has now reached a point where it is possible to determine this with a high degree of accuracy and laboratory results can always be supplemented by field tests.

Advantages of Single Standard.—The working out of this situation and establishment of a single standard quality specification for cement has had, and must continue to have, many advantages for consumers, producers, and the community as a whole.

The engineer and designer can rely upon getting anywhere the standard quality cement contemplated by the plans.

Concrete can be designed of definite strength and quality.

Simple rules have been made by which even the inexperienced can with care get good concrete.

Greater efficiency in production, lower cost has been made possible through continued operation a standard product.

A standard product can always be kept in stock ready for use.

Wider production of cement has been made possible by eliminating unnecessary limitations on raw materials. In 1922 cement was produced in 118 plants in 27 states, compared with 65 plants in 19 states in 1902.

Nearness of production to markets has followed wider production. When it is known that the freight charges on a barrel of cement for an average 100-mile haul are about 30 per cent of the average mill price per barrel for the last three years reported by the U. S. Geological Survey, the importance of this will be appreciated.

Each standard established makes easier the establishment of other standards. The establishment of the cement specification makes easier the establishment of a specification for concrete. In the concrete specification now in process of formation, the cement specification and specifications for twelve other materials or methods entering into the making of concrete are included.

Better and cheaper concrete structures are the net result.

Conclusion.—The Bureau of Standards deserves the very highest credit for the sturdy support and valuable assistance it has given to all cement standardization work. The industries of this country will do well to become familiar with and utilize its facilities and knowledge readily placed at their disposal. The opportunity offered by the American Society for Testing Materials for co-operative work on specifications within its field is worthy of attention.

Industries which have not already established standards may well consider carefully the advantage of determining standard specification requirements through voluntary action by consumers and producers, rather than wait for a specification determined by some outside authority to be imposed upon them.

The principle underlying this standardization is that underlying all progress—the movement from the indefinite to the definite. The trend is certain. To voluntarily accelerate progress in the direction it will inevitably take, is the part of wisdom.

Remove Signs from Right of Way.—Secretary Wright of the Department of Highways of Pennsylvania calls attention of candidates for office to the fact that under the state law no advertising matter of any kind may be posted within the legal limits of the roadway.

"Candidates for office, managements of fair associations, automobile dealers, hotel and restaurant men, and others," said Mr. Wright recently, "will be money in pocket if they refrain from posting advertising matter within the legal limit of the roadway. These signs, if posted, will immediately be destroyed by caretakers and patrolmen."

Prof Hatt Returns to Purdue.—Prof. W. K. Hatt will resume his duties as Professor of Civil Engineering at Purdue University, Lafayette, Indiana, having completed two years leave of absence in the service if the Advisory Board on Highway Research of the National Research Council. He will continue to direct the affairs of the Advisory Board during the immediate future.

Water Works

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.
221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*
LEWIS S. LOUKE, *Vice-President and General Manager*
New York Office: 904 Longacre Bldg., 42d St. and Broadway
RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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Vol. LX. CHICAGO, ILL., SEPTEMBER 12, 1923 No. 3

Developing Inland Water Transportation

The public in its attitude toward our inland waterways may be divided roughly into five groups—the great mass which takes no interest and scarcely knows of their existence; the few who still find satisfaction in declaiming on our "limitless natural resources" and "unequaled achievements;" the pork barrelers who boost incontinently so long as construction funds can be turned their way; the opposition comprising a mixture of certain of the least public spirited railway interests and of persons disgruntled over past waterway failures; and finally the unprejudiced students and observers who, while regretting the wastes and grafting which have been so conspicuously associated with public waterway expenditures, nevertheless see and hope to realize the really great opportunities that exist in this field.

Why have our waterways not prospered? Why have they been so little favored for many years? For some of them the answer obviously is that they never should have been built. These for most part are the pork barrel waterways. The better class of projects—those that had real merit in conception and reasonable efficiency in construction—have disappointed, we believe, principally because they lacked an adequate and efficient operating organization.

For obvious reasons the transportation of high priced and perishable goods goes to the rail in preference to the water routes; but the railroads also get a vast tonnage of non-perishable commodities of large bulk and weight in proportion to their value which undoubtedly could be handled more economically by water. That these commodities are not so handled through territory in which water routes exist must be attributed to the failure of water carriers to make this form of transportation attractive. The shipping public has acquired "the railroad habit" because the railroads give a service that can be depended upon within reasonable limits, and at the same time actively and intelligently sell that service; while neither

To the Engineers of America

Owing to the awful calamity that has just occurred in Japan, many of our brother engineers in that country must be in dire need, and will be for some time to come—as will be also the families of those engineers who have perished. It has struck me that it would be a kind and friendly act for the engineers of America to contribute individually but as engineers through the New York City Branch of the Yokohama Specie Bank, one half of the money thus sent being used immediately for general relief of the suffering populace, and the other half later for engineers and their families. I have arranged with the Manager of the Bank to receive and distribute in that manner all moneys thus sent, working later through the Civil Engineering Society of Japan. Please make checks payable to Engineers' Relief Fund of Yokohama Specie Bank, the address being 120 Broadway, New York City.

For years it has been an earnest desire of mine to see the peoples of Japan and America brought permanently into harmony and close friendship, and if we Americans now help the Japanese generously in their hour of need, they will never forget it; because, from long personal experience, I know them to be a truly grateful and appreciative people.

I trust that each of you will contribute as liberally as he can, but even small amounts would help—on the principle that "mony a little maks a muckle."

J. A. L. WADDELL,
Consulting Engineer,
New York.

corresponding reliability nor equal salesmanship have been forthcoming from the water carriers.

We would not suggest that it is wholly an easy matter to operate a line of boats on schedule and to advertise that fact to every possible shipper; still less that these are the only problems in the case. For one thing, terminal facilities are as essential as are boats, and like boats and operation and selling the service, they are costly. But the problems are not insoluble, and we firmly believe that a profitable private industry can be built up, and a public benefit conferred by the development of inland water transportation.

The development will require confidence, skill and patience. Capital, which will be required in substantial amount, will not be forthcoming until there is clear evidence that the enterprise is both safe and profitable. Then following all preparatory expenditures and the commencement of operation will come the development period in which the bulk of the business must be acquired. The better the salesmanship, the shorter will be this period, but patience must be exercised, for no salesmanship or other ability can reduce the period to zero. The hostile factions of the public must be conquered or won over; shippers in the indifferent group must be educated; and pork barrel practices must be combated so that construction may be carried on where it is most needed.

The problems are man-size, but fortunately the supply of men keeps up, and we believe that the opportunities in inland water transportation will not much longer lie in the neglect in which they have reposed for a generation or more.

Mineral Contamination of Water

In spite of the large amount of creditable work that has been done in the correction of mineral impurities in public water supplies, there are still many places throughout the country in which the supplies have a highly objectionable mineral content, and in which it is important that improvements be secured. Since the more pressing problem of eliminating disease breeding bacteria has been solved

almost perfectly, it is not unreasonable to expect more attention henceforth to be given to mineral purification.

The problem of eliminating minerals is in some respects at least simpler than that which faced sanitarians in their fight against bacteria. The mineral content of water in most cases is a definite quantity that does not require constant watching as does bacterial contamination, and it is susceptible of definite and easy chemical analysis.

Its treatment on an economic commercial scale, however, is a problem of the first rank. There is great variety in the number, kind and quantities of minerals involved, and a variety of means must be used in contending with them.

Simple hardness, objectionable tastes, unhealthfulness, and colors which stain goods in washing are some of the defects which are found in public water supplies in this country, and which are felt by almost every user. Special industrial processes often require large quantities of water of a purity considerably above what would suffice for most purposes.

Mineral purification should afford an attractive field of experiment, for success with even one class of impurities means a worth while benefit to mankind.

First 9 Years' Operation of Panama Canal

The Panama Canal completed 9 years of operation at the close of business on Aug. 14, 1923, having been opened to commerce on Aug. 15, 1914. The operation during these 9 years is summarized as follows in the Panama Canal Record:

During the 9 years of operation the total number of commercial vessels transiting the canal was 20,474. They carried 84,284,474 tons of cargo through the canal.

The canal was opened to commercial traffic shortly after the beginning of the war in Europe. The war and the interruptions of traffic due to slides, the last serious one of which came to an end on April 15, 1916, interfered with the normal use of the canal in earlier years. These years were followed by a period of scarcity of tonnage, high freights and financial and industrial uncertainties, which in turn led to a period of widespread commercial stagnation wherein cargo offerings reached a low ebb and a large proportion of the tonnage of all the maritime nations were withdrawn from service.

During all this period, however, except for temporary depressions, traffic through the canal has shown a consistent increase. The past year has been by far the best of all, and has been marked by an almost uninterrupted succession of record months, wherein the shipping of practically all of the leading maritime nations routed through the canal has shown a healthy increase. The largest increase has been in vessels of United States registry, resulting from the increase in the intercoastal trade. The increased intercoastal trade in turn is largely due to the development of the California oil fields and the consequent heavy movement of tanker tonnage through the canal.

In Table I, a summary of traffic through the canal during the first 9 years of operation is shown, listing the number of vessels, the Panama Canal net tonnage, cargo tonnage, and tolls collected. This tabulation lists only vessels paying tolls. The amounts given for tolls are approximately correct; to arrive at the receipts for the periods 15th to 31st and 1st to 14th of each August except 1914 and 1923, the total for the month was divided in proportion to the number of days:

Table I

Period from—	No. of Vessels	Panama Canal Net Tonnage	Cargo Tonnage	Tolls
Aug. 15, 1914 to Aug. 14, 1915	1,311	4,560,774	5,861,785	$5,171,757
Aug. 15, 1915 to Aug. 14, 1916	729	2,310,408	2,973,206	2,251,433
Aug. 15, 1916 to Aug. 14, 1917	1,854	5,904,580	7,132,694	5,753,156
Aug. 15, 1917 to Aug. 14, 1918	2,051	6,487,214	7,431,495	6,365,203
Aug. 15, 1918 to Aug. 14, 1919	2,027	6,198,874	6,981,996	6,286,927
Aug. 15, 1919 to Aug. 14, 1920	2,580	8,905,818	9,839,918	8,965,342
Aug. 15, 1920 to Aug. 14, 1921	2,860	11,527,138	11,330,400	11,247,739
Aug. 15, 1921 to Aug. 14, 1922	2,790	11,788,742	11,522,018	11,532,596
Aug. 15, 1922 to Aug. 14, 1923	4,272	20,283,394	21,210,962	18,975,189
Total to Aug. 15, 1923	20,474	77,966,942	84,284,474	$76,549,346

Water Works and Sewer Contracts Awarded During the Last 43 Months

The accompanying tables show: First, that the waterworks and sewer contracts awarded during the last half of each year exceed in volume those awarded during the first half; second, that there is not a month in the year without a very large volume of waterworks and sewer contracts; third, that each year shows a gain over its predecessor in the volume of contracts awarded in this "hydraulic field."

The volume of irrigation and drainage contracts will surprise any one who has not followed closely statistics of this sort.

WATERWORKS CONTRACTS EXCEEDING $25,000 IN SIZE.

	1920	1921	1922	1923
January	$ 1,144,000	$ 519,000	$ 1,727,000	$ 4,720,000
February	2,172,000	2,927,000	652,000	2,730,000
March	2,213,000	2,028,000	1,093,000	15,149,000
April	2,719,000	3,342,000	2,673,000	8,544,000
May	1,382,000	4,944,000	3,568,000	7,329,000
June	1,461,000	3,485,000	5,124,000	4,045,000
July	3,793,000	3,106,000	811,000	3,803,000
August	775,000	2,404,000	4,494,000	.....
September	743,000	1,487,000	3,906,000	.....
October	11,169,000	900,000	7,686,000	.....
November	2,151,000	4,698,000	2,161,000	.....
December	1,051,000	10,752,000	1,885,000	.....
Total	$30,773,000	$40,602,000	$35,730,000	.....

Note.—About 100 per cent must be added to the annual totals to give the grand total of contracts awarded in the United States.

A great deal of waterworks construction is done by directly hired labor and is not included above.

Waterworks buildings are not included above.

SEWER CONTRACTS EXCEEDING $25,000 IN SIZE.

	1920	1921	1922	1923
January	$ 1,864,000	$ 3,147,000	$ 2,267,000	$ 3,322,000
February	623,000	2,445,000	2,462,000	2,131,000
March	1,283,000	2,862,000	3,796,000	4,477,000
April	4,124,000	3,817,000	2,794,000	5,497,000
May	2,315,000	2,162,000	5,722,000	9,052,000
June	2,349,000	3,802,000	5,158,000	6,501,000
July	3,163,000	3,986,000	1,869,000	3,183,000
August	2,437,000	3,988,000	3,450,000	.....
September	2,319,000	5,064,000	3,340,000	.....
October	3,052,000	2,829,000	4,996,000	.....
November	4,572,000	2,733,000	5,349,000	.....
December	2,967,000	2,549,000	2,381,000	.....
Total	$36,068,000	$39,384,000	$43,584,000	.....

Note.—About 100 per cent must be added to the annual totals to give the grand total of contracts awarded in the United States.

A considerable amount of sewer construction is done by directly hired labor, which is not included in the above totals.

IRRIGATION, DRAINAGE AND EXCAVATION CONTRACTS EXCEEDING $25,000.

	1920	1921	1922	1923
January	$ 1,542,000	$ 1,266,000	$ 2,091,000	$ 548,000
February	787,000	306,000	419,000	365,000
March	3,151,000	1,626,000	608,000	28,993,000
April	416,000	580,000	1,736,000	2,506,000
May	404,000	2,632,000	776,000	3,553,000
June	605,000	1,240,000	2,628,000	1,174,000
July	1,942,000	609,000	1,498,000	6,902,000
August	4,179,000	89,000	6,920,000	.....
September	859,000	9,025,000	876,000	.....
October	1,086,000	373,000	2,390,000	.....
November	772,000	726,000	1,741,000	.....
December	477,000	707,000	864,000	.....
Total	$16,220,000	$19,179,000	$22,547,000	.....

Note.—About 100 per cent must be added to the annual totals to give the grand total of contracts awarded in the United States.

Waterproofing a Reinforced Concrete Standpipe

Method of Preventing Leakage in 16-Year Old Structure at Waltham, Mass.

One of the most interesting accomplishments of the Water Division of Waltham, Mass., in 1922, was the waterproofing of a reinforced concrete standpipe. The work is described by George C. Brehm, City Engineer and Director of the Department of Public Works, in the annual report of his Department, from which we quote as follows:

This reinforced concrete standpipe was constructed in 1906 and was at that time the largest of its type in the country. The construction was of 1:2:4 concrete, the wall being reinforced with steel bars arranged in three rows up to 20 ft., two rows for the next 17 ft. and one row to the top, same being designed to keep tensile stress within a 12,000-lb. limit. The roof consists of a concrete slab 3 in. thick supported by steel trusses radiating from a central concrete covered pipe column, which served also as an overflow.

Open Reservoir, Concrete Standpipe and Temporary Standpipe in Foreground.

The standpipe is 100 ft. in diameter, 43 ft. high with a capacity of a little over 2,000,000 gal. of water, and is situated in the western end of the city on a ledge knoll. The original cost of this reservoir was about $26,000. The specifications for this construction were prepared with the greatest care. The engineers in charge did everything possible to produce a concrete which would be absolutely watertight. Every precaution known at the time was taken to insure against the slightest seepage.

The First Attempts at Waterproofing.—In spite of the precautions at the time of construction leakage developed after a few years. In 1914, an ill-advised attempt was made at waterproofing by the application of a coat of pitch to the inside wall. This amounted to very little and another attempt was made shortly after by the application of cement, using a cement gun, on the outside, but neither of these methods proved satisfactory, the seepage continued and successive frost action caused several large areas of the outside wall to disintegrate, the surface breaking in several places to such an extent that the reinforcing rods became slightly exposed at several spots.

The water level of the standpipe when full is 256 ft. above sea level. The city also has adjacent to this standpipe an open reserve reservoir with a capacity of 6,000,000 gal., the elevation being, when filled, approximately 205 ft. above sea level. Between the year 1914, when the first attempts were made at waterproofing, and the present, the water system of this city has been extended to the developed outlying sections of the city, and at the present time requires an elevation of not less than 235 ft. at all times for the convenience and safety of the whole city, especially the outlying sections.

The problem therefore confronting the city officials was to keep sufficient pressure to insure the convenience and safety of the whole city with their water supply while a thorough and final job of waterproofing was being done. It was obvious that the reserve reservoir at an elevation of 205 ft. would not insure the supply.

The Temporary Standpipe.—The idea was conceived of erecting an 8-in. pipe in the vicinity of this standpipe, tapping the 24-in. feeding main with a 24x8-in. Smith tapping sleeve and valve, and, by keeping the pumps con-

tinuously operating, maintaining a head of water at all times at sufficient height to insure the city supply. A wrought iron, 8-in. pipe was therefore erected to a height of 276 ft. above sea level, and guyed for safety. The pumps at the pumping stations were

The Temporary Standpipe.

then set in operation, the pumping continued for 24 hrs. per day, the speed of the pumps being regulated to maintain enough pressure to drive the water to the top of this pipe sufficiently to have a slight overflow, the pipe being erected so as to allow this overflow spill to drop into the open reserve reservoir.

The Waterproofing Operations.—The contract for the waterproofing having been previously let and all details arranged, the large concrete standpipe was emptied, the inside wall thoroughly cleaned and dried, a number of salamanders being used to hasten the drying. After the walls were thoroughly dried, the waterproofing was started. It consisted, first, of a mop coat of Texaco No. 56 Waterproofing material applied hot to the inside face of the wall. Immediately outside of this was applied a coat of waterproofing felt, the surface of the same being mopped with another coat of Texaco No. 56 Waterproofing asphalt. This operation was repeated for five layers, the outside layer, however, being of 6-oz. saturated duck fabric, and the outside surface of this finally mopped with the waterproofing asphalt. Immediately following this, a 4-in. brick core was constructed from the floor to the top of the wall, great care being taken to obtain a ½-in. mortar course between the outside asphalt course All of this work, of course, was started at the bottom and built up the entire inside circumference of the wall and the inside face of the brick work. in 6-ft. sections.

The work was started Nov. 20 in spite of the most inclement weather and was finally completed and the reservoir refilled on Dec. 23. As the stagings on the side of the wall were taken down, the whole inside face of the brick core was thoroughly cleaned by washing.

Tractor Used in Hoisting Materials.—It is of interest to note that all the materials used in this work had to be hauled to the very inaccessible point where the reservoir is located, raised to the top and lowered through a 4x4 ft. hole made in the concrete roof. Instead of the usual steam or electric

Method of Hoisting Material.

power for hoisting, the contractor used a medium sized tractor, rigging a boom derrick on top of the reservoir, fastening the hoisting cable to the front of the tractor, which moved up

and down the country road at the side of the standpipe, raising and lowering all the materials in a hoisting pan in this manner.

Simpson Brothers of Boston were the general contractors on the work, W. A. Murtfeldt Company of Boston sub-contractor on the waterproofing, and M. F. Stankard of Waltham sub-contractor on the brick work. The engineer's estimate on the whole of this work was $16,500, while the low bid of the contractor for the whole work was $16,543. The materials used in the work were about as follows:

15 tons of Texaco No. 56 Waterproofing asphalt.
150 rolls of felt.
550 bags of cement.
100 bags of lime.
85,000 brick.

The reservoir has been refilled and every indication shows that a complete waterproofing job has been obtained and that no further seepage is possible. As soon as the weather permits it is recommended that the outside walls be touched up with mortar where disintegration has taken place and the whole outside walls be given a thin stucco finish for the sake of appearance and protection.

Boiler Plant Operation at St. Louis With Fuel Oil

As a result of the general coal strike of last year the water works of St. Louis, Mo., were compelled to resort to oil as fuel for the operation of the boiler rooms of the pumping stations. We are indebted to the recently issued annual report of Edward E. Woll, Water Commissioner, for the following details:

The strike, starting in the early part of April, did not affect the operation of the boiler rooms until the middle of June, because of the use of coal from the reserve storage sheds and from the large quantity of screenings furnished under contract and stored on the grounds surrounding the Boiler Rooms. As the reserve supply diminished, additional coal was purchased from West Virginia, Alabama and Kentucky. With the Kentucky coal averaging 12,500 B.T.U. per lb., the evaporations at all plants were increased. Toward the latter part of July the Water Division was compelled to resort to oil as fuel for the operation of the boiler rooms. Table I is a record of the boiler rooms at the respective stations operating with fuel oil.

For the three stations the average fuel oil cost per 1000 lb. steam was $0.5263 as compared to the average coal cost per 1000 lb. steam of $0.2999. The increased cost of steam, due to burning oil, was $0.2264 per 1000 lb. or 75.5 per cent. The average cost of the oil burned during the strike was 4.7 ct. per gallon, which is equivalent to coal at $7.13 per ton, with a heat value of 19,000 B.T.U. for oil and 10,700 B.T.U. for coal, which is an average B.T.U. value for coal burned this year at all stations.

The stoker furnaces at all stations were changed to oil burning in 24 working hours. The changes in the furnaces consisted of removing the feed gates from the stokers and laying a floor of fire brick on top of the chain grates from the bridge wall to a front wall or seal in the stoker hopper. This front wall had three openings for the burners. The burners were of the flat spray outside mixing type. Steam was used for atomizing and the oil was preheated for better volatization. Had the stokers been removed from the furnaces, a larger combustion space would have been available and a better evaporation secured but the extra cost of labor for removing and dismantling the stokers would probably have discounted the small increase in efficiency. While the burning of fuel oil was an emergency proposition, the efficient operation of the boiler rooms was maintained.

With the settlement of the strike the Bissell's Point plant changed back to coal on Oct. 7, and the plants at Baden and the Chain of Rocks returned to coal the latter part of the same month.

Table I

Station	Pounds of Oil Burned	Cost of Oil	Steam Generated	Cost of Oil Per 1,000 Lbs. of Steam
Bissell's Point	4,568,400	$28,921	54,061,570	$0.5349
Baden	5,782,800	36,525	69,597,007	0.5248
Chain of Rocks	7,108,200	45,083	86,370,206	0.5219
Total	17,459,400	$110,529	210,028,783	$0.5263 Ave.

Repumping vs. Increased Pressure for Fires

A Paper Presented Before Canadian Section of the American Water Works Association

By ARTHUR JENSEN,
Superintendent Water Works, Minneapolis, Minn.

Municipalities of any considerable size depend upon both water and fire departments for protection against fire losses. They are interdependent in their obligations but they are by no means the only agencies to be relied upon for this protection. Another important factor is that of fire protection and fire prevention. There may be a difference of viewpoint of the fire chief and the water superintendent in these matters because of the variation in the nature of the services rendered by their respective departments. It is the purpose of these remarks to point out some of the conditions met with in the matter of auxiliary pressures in a water system as compared with pressures raised by the use of fire apparatus. These remarks are set forth from the standpoint of the water works superintendent.

Duty of the Water Works.—A water works system is installed for the purpose of providing water supplies for the following purposes:

A. 1. Domestic supply. 2. Sanitary use. 3. Industrial purposes. 4. Public use.

B. 1. Fire protection.

The reason for placing the use of water under two headings is due to the fact that the supplies may be furnished under different conditions of pressure and quantity. For group A the water may be supplied by gravity, by semi-direct pumping, by pumping to a reservoir and from thence by gravity or by direct pumping. If the water is purified it may complicate any of the gravity and pumping features by reason of the necessity of separation of raw and filtered water. For group B the water may be supplied by any of the above methods augmented by increased pressures in certain cases. Only where direct or semi-direct pumping is employed is it very practicable to secure increased pressures for fire supply.

Water supply development has kept pace with municipal growth but ordinarily few changes have been made in the matter of changes of pressure for either ordinary use or for fire purposes. The reasons for this are due to the nature and mode of supply which present physical conditions not adaptable to the application of changes of pressures as well as the strength of the pipe system.

Methods of Distribution in 155 Cities.—In the Statistics of Cities for 1915, issued by the Department of Commerce, data is given covering 155 water supplies of principal cities in the United States. The tables for sources of supply and modes of distribution show the following facts:

Modes of Distribution	Per cent of Total
Gravity of practically all gravity.....	13
Pumping with impounding and distributing reservoirs	12
Pumping with standpipes and tanks	22
	47
Direct or semi-direct pumping.....	53
Total	100

This proportion is applicable, generally speaking, to all water supplies. It may be assumed that about 53 per cent of water supplies are distributed by more or less direct pumping and that 47 per cent have some form of reservoir in the distribution system. The presence of reservoirs, tank and standpipes in the gridiron indicate the practice of maintaining constant pressures in the distribution of water. The application of higher pressures is not possible without closing off reservoir structures during the time required. The above data show such procedure is not possible in 47 per cent of the water plants without more or less complication. In the 53 per cent of supplies having direct pumping, increased pressures are possible, provided that the pumps, mains and other water carrying structures will permit.

It has already been pointed out that the demands for fire fighting are such that the ordinary increase of pressure possible and allowable in a water plant is insufficient for the requirements of today. Pumping plants are not, as a rule, adapted to carry increased pressures. Centrifugal pumps operating at constant speeds at given pressures and at the highest point on the efficiency curve fall off in both

capacity and efficiency under pressure conditions. The attendant grave danger and risk of damage to pumps, mains, services, plumbing and other structures as well as the cost and inadequacy of such service has brought about a decrease in the practice of raising the pressures in water systems for fire protection.

This statement is borne out by a report covering 143 cities in the United States having a population of 50,000 and over in 1920, by Charles R. Henderson, manager of the Davenport Water Works. It is shown in this report that only 26 per cent of the cities listed indicate that it is possible to increase their pressure for fires. Most of the increases are made in the smaller plants. Some of the changes of pressure are made only on special request or for very important fires. In some cases the increases ranged only from 4 to 15 lb. which is of no material benefit. The average increase of all the cities is only 24 lb.

In the report notations are made that certain cities are giving up the practice or that increases are possible if required, indicating that in those cities the increases are not being made. By eliminating these, it is found that only 18 per cent of these cities are actually making a practice of raising pressures in the water system upon fire alarms.

It is quite clear that water plants are not suited for actual fire fighting and that it is not common practice to raise pressures for the purpose. It also appears that where pressures are raised that are still lower than that required for effective fire fighting in important cases. A large investment has been made in water plants for pumps, large mains and hydrants for delivery of water for fire use. In the application of the means at hand, the duty that falls upon the water department, under the circumstances, is to furnish an ample supply of water at sufficient hydrant outlets for fire purposes, but it is not incumbent upon the department to put the water on the fire.

Duty of the Fire Department.—Thoroughly drilled men form highly efficient units for fire duty. They are skilled and resourceful and ready for any emergency. High buildings and extensive structures require added facilities for fire protection. These have been developed to meet the requirements. Higher water pressures are provided by powerful motor driven pumps which are an integral part of the equipment. Towers, turrets, pipes and various scaling devices are employed for high buildings.

In addition to the portable equipment, there have been installed in some cities high pressure distribution systems for fire service. These are virtually powerful stationary fire engines attached to high pressure mains distributing water to high value areas. The water is applied by ordinary methods from special hydrants. These systems are prohibitive in cost except in limited districts, but are very effective. Their general development has been retarded by these limitations and by the advancement of design of fire apparatus available for service in all parts of the city.

Fire Protection and Prevention.—There is another phase of this subject that is as important as the water works plant and the fire department. An ounce of fire prevention is worth a ton of cure in that way of later effort on the part of the fire and water departments. Fire protection and prevention is the effort that can be made to take a part of the burden off from both departments.

The principal remedies offered under this head consists of the effective use of construction materials of fireproof qualities, the absence of permanent combustible fixtures so far as practicable, and the adequate employment of automatic sprinkler systems. To this may be added such auxiliaries as automatic alarms, extinguishers, hose reels and nozzles. The human agencies that may be employed are watchmen, inspection of premises and disciplining of tenants.

The hydrant brings the water to the curb, but ordinarily it must be applied from that point by human agencies. By the sprinkler system the water is carried into the structure, requiring only a critical temperature for its application. It forms a trap for the incipient fire and is very effective in the prevention of monetary losses.

In a report of the National Fire Protection Association, covering 14 years and embracing 11,257 fires in premises protected by sprinkler systems, the following interesting facts are shown:

Manner of terminating fire	Number	Per cent
Extinguished by sprinklers	7,181	63.8
Held in check by sprinklers	3,514	31.2
Unsatisfactory	562	5.0
Total	11,257	100.0

The 5 per cent of unsatisfactory cases are tabulated in detail and it is shown that they were due to such causes as water being shut off, crippled by explosion, freezing, obsolete equipment, shut down for repairs and like interference. The lesson is clear, however, and the importance of sprinklers is admitted. The use of fireproof materials of construction is of similar importance but there is no data available for numerical tabulation showing the reduction of possible fires.

Cost of Increased Pressures.—Apparently there is no data available whereby it is possible to compare the cost of fire engine pumping with the cost of increasing pressures in the water system, due to the fact that the latter costs are concealed in the general expense of the pumping and distribution plant. Ignoring any niceties, a basis can be made upon which certain costs may be constructed to illustrate the economics involved and will be offered for what they may be worth.

The frequency for the necessity of higher pressures is indicated by figures compiled in New York City by Freitag for the year 1908. They are as follows:

Total number of fires	8,642	
Extinguished, no engine used	5,258	60.8%
Extinguished, one engine used	2,657	30.7%
Extinguished, two engines used	562	6.5%
Extinguished, three or more engines and high pressure system used	165	1.9%

The number of fires covered in this table is sufficient to make the figures significant. In scarcely 2 per cent of the fires were more than two engines or the high pressure fire system used or needed. If this ratio is applied to smaller cities, it appears that the importance of increased pressures is equivalent in numerical value to about 2 per cent of the number of fires. The amount of water used by New York City in that year for fires is reported as 191,791,000 gallons or less than one day's average consumption. This ration will also apply to most large cities.

In view of these facts it is a simple matter to show approximately how much water must be pumped by fire engine pumps per year in any of the larger cities. The relative costs of repumping this water must be compared with the cost of maintaining increased pressures by the water works pumping station during the hours required.

As a basis for this comparison the data is made up for a city having a population of 400,000 people. The distribution system is constructed of pipe which is equivalent to Class B, and the pressure averages about 70 lb. It is assumed that it is desirable to raise the pressure for fire protection. To be at all effective such increased pressure should be at least 50 lb. This would require Class C pipe which would permit a pressure of 130 lb. In this case such a situation would allow an increased pressure of 60 lb.

In order to make a distribution system adequate for this pressure it should be constructed of Class C pipe. An analysis shows that the additional weights of pipe would increase the cost of the distribution system 4.45 per cent. Valves and specials are considered ample for the additional charge of from $5 to $10, but as most services are the property of private parties, the item will be omitted for conservative reasons only. The increased cost of pumping machinery will probably be not less than 10 per cent.

It is found that on the above items alone the additional investment necessary to properly permit increased pressures as a regular safe practice in this case is $412,000. The fixed charges, including depreciation, may safely be placed at 6 per cent. This will represent an annual charge of $24,720.

The number of fires over one hour in duration in 1922 was 259, and the number of fires over two hour's duration was 79. Average duration of these fires was 3.7 hours. In this discussion it is reasonably assumed that additional pressure would be supplied at the above 79 fires. It is also assumed that the total amount of water used for fire purposes for the year was 30,000,000 gal.

The summarized data is given as follows:

Number of fires requiring additional pressure	79
Total hours of increased pressure	292
Equivalent days	12.16
Average daily consumption, million gallons	40
Total million gallons pumped against increased pressure	486
Average cost of power per M. G. per foot	$0.0340
Increased pressure, pounds	60
Equivalent head in feet	138
Total pressure in pounds	130
Cost of power for pumping against 138 additional feet per million gallons	$4.69
Cost of pumping 488 M. G. against 138 additional feet of head	$2,279.34

Annual fixed charges, 6%	$24,720.00
Number of million gallons applied to fires	30
Cost for pumping per M. G. applied water	$75.97
Cost for fixed charges per M. G. of applied water	$824.00
Total cost per M. G. for pumping high pressure water into distribution system	$899.97

The cost of re-pumping by motor pumps of fire apparatus against a similar pressure may be approximated in a similar manner. Using 1,000 gal. per minute as the capacity of the pumpers, the number of pump-hours for 30,000,000 gal. would be 500.

The data is as follows:

Number of gallons of gasoline per hour	12
Total pressure pumped against, pounds	131
Oil, waste, etc.	$0.50
Cost of gasoline	$3.00
Total cost of power to pump 30 M. G.	$1,750.00
Number of pumps considered for maximum demand, equivalent of present capacity	10
Cost of 10 pumpers	$130,000.00
Total annual charges at 10%	$13,000.00
Cost per M. G. pumping expense	$58.33
Cost per M. G. annual charges	$433.33
Total cost per M. G. supplied by pumpers	$491.66

The items of maintenance and repairs have not been included, but in the water plant they certainly would be greater than the amounts needed for the upkeep of fire apparatus whose action in hours per year in actual pumping is not very great. It appears that the actual cost of pumping in the water plant is nearly 30 per cent greater than in the case of motor pumps and the total cost nearly double when the investment is considered. The items used in these computations are unsatisfactory from the standpoint of exactness but they serve to shed some light upon the subject which may lead to further discussion.

Conclusion.—In conclusion it may be said that re-pumping by motor pumpers is more economical when adequate pressures are considered than increased pressures in the water system. Fire apparatus is more flexible, mobile and efficient for fire fighting than ordinary hydrant pressures. Its use obviates the risk of applying additional pressures to water mains, services and plumbing at critical hours.

Statistics indicate that about 80 per cent of water plants do not increase their pressures for fires and that fire departments do not depend upon water systems for such pressures but develop their own pressures either by motor pumps, separate high pressure systems, or both.

It is apparent that with greater application of sprinkler system and well organized fire fighting units equipped with modern appliances, that water departments may function in their proper sphere, viz., to deliver water under economical and safe conditions for the general use of the community.

Comparison of Lead, Leadite and Cement Joints

A series of electrical resistance tests on three lines of 3 in. cast iron pipe, one laid with lead joints, one with cement and the third with leadite were made during the past year by the Distribution Section of the Water Division of St. Louis, Mo. After finishing the tests, both with the pipes full of water and empty, the lines were put through a very severe deflection test by raising and lowering one end with a derrick. The conclusions are summarized as follows in the recently issued annual report of Edward E. Wall, Water Commissioner of St. Louis.

1. Cement and leadite are far superior to lead as insulators and the insulating value of these materials is not vitiated by the water in the pipe. Their use would have prevented most of the electrolytic trouble to which our cast iron system is subject at present. This statement is made in full cognizance of the fact that the insertion of an occasional insulating joint may lead to joint electrolysis caused by the current leaping around this particular joint and continuing along the pipe line. The point is that if every joint were insulated the current would not have the incentive to travel the main in the first place.

2. Cement and leadite will stand far more deflection than lead without serious leakage.

3. Lead and leadite joints can be made in any season and under adverse conditions, while cement is at a disadvantage in winter and in wet trenches.

4. Lead and leadite joints permit the water to be turned on and the line put in service immediately, while cement requires a period of preliminary setting.

5. Cement joints are very hard to gouge out.

6. The sulphur fumes given off by the molted leadite might become very oppressive in a confined space.

Deflection Measurements on Arch Dam in Switzerland

Swiss Tests on 75 Ft. High Variable Radius Type Diversion Dam on River Reuss

By F. A. NOETZLI,
Structural and Hydraulic Engineer, San Francisco

A very slender arch dam was recently constructed in Switzerland, and the deflections of this dam were measured at various elevations and for different depths of water when the reservoir was filled for the first time. The deflection measurements were made with an unusual degree of accuracy, and these tests seem to confirm, in a measure, the correctness of the assumption of elastical cantilever and arch action in this structure.

The dam is located on the river Reuss near the town of Amsteg, and is used for diversion purposes in connection with a power development for the electrification of the St. Gotthard railroad. The dam is about 75 ft. high above stream bed and spans a very narrow gorge of the river. The width of the canyon at the crest of the dam is approximately 100 ft. and the canyon walls consist of solid granite, so that the conditions were very favorable for the construction of a thin arch dam. The structure is of the variable radius type, and it was designed according to the modern method of combined cantilever and arch action. The dam is built of cut granite with very thin mortar joints between the individual blocks which were cut and placed by expert Italian masons.

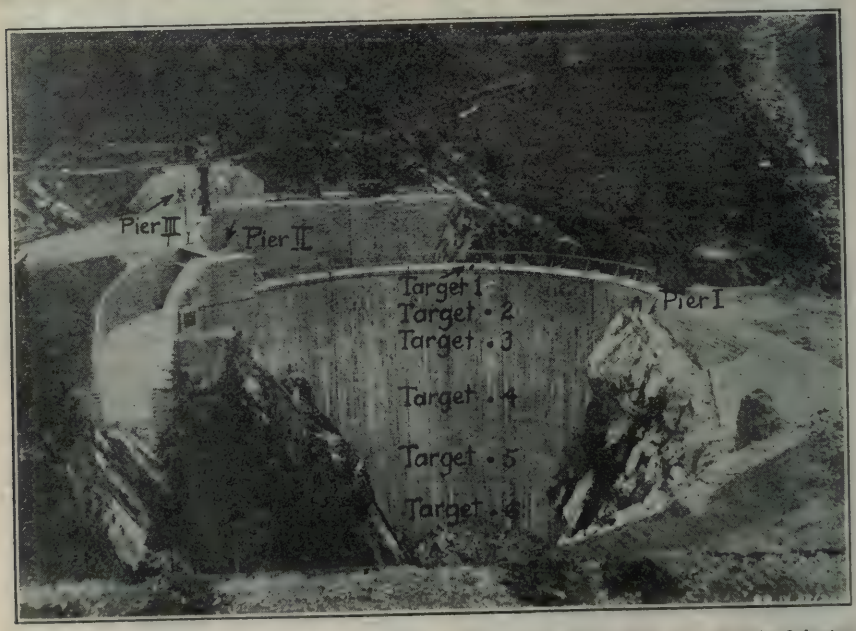

Fig. 1. View of Downstream Face of Amsteg Dam (Locations of the 6 targets and the 3 instrument piers are indicated).

The up-stream radius of the dam is 66 ft. at the crest and decreased to 46 ft. at about stream bed. The arches are 3.3 ft. thick at the crest and 11.5 ft. at a depth of 70 ft. below the top. Below this point the curvature and the thickness of the arches are uniform.

The deflections of the dam were

measured at various reservoir levels, when the dam came under pressure for the first time in July, 1922. The reservoir created by the dam has a very small capacity (about 160 ac. ft.) as it is used only as a forebay for the power plant. At the time of the test the flow of the river was such that the reservoir filled in about half a day. The conditions were therefore ideal for ascertaining the arch deflections due to water pressure alone, inasmuch as the rapid rate of filling did probably not permit the temperature of the dam to change materially during the period of the observations.

Arrangement of Deflection Measurements.—On the down-stream side of the arch crowns, six targets of suitable shape were set into the masonry at various elevations of the dam. Fig. 1 is a view of the down-stream face of the dam, and the location of the targets is marked by the points 1 to 6. Two instrument piers I and II, were built on solid rock near the abutments of the dam, and the movements of the targets were measured by "intersection" from these piers. Fig. 2 is a plan of the dam, showing also the location of the observation piers and of the targets.

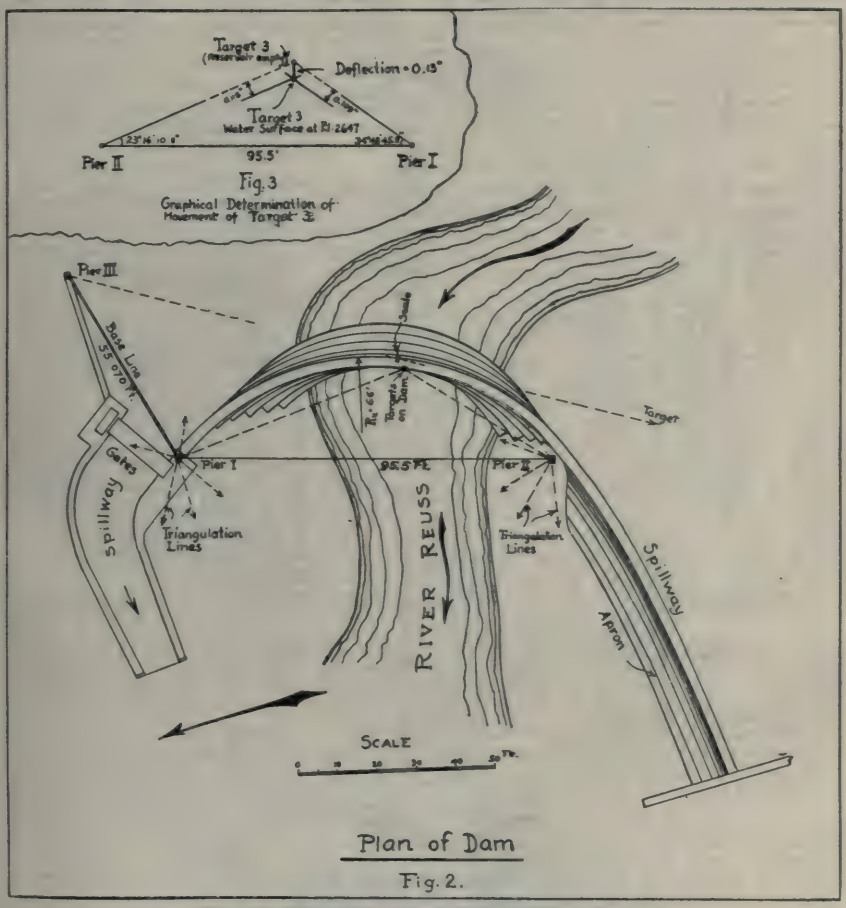

Fig. 2. Plan of Dam and Triangulation System.
Fig. 3. Graphical Determination of Deflections.

It was anticipated that the deflections of the dam would be very small, particularly during the initial stages of the filling of the reservoir. The use of the most accurate instruments available and the services of the best

trained observers were therefore imperative.

The making of the tests was entrusted to the Swiss Geodetic Survey, and the observations were made by its Chief Engineer, H. Zoelly and his assistant, W. Lang. The instruments were high grade theodolites as used for primary triangulations, and which permitted to read the angles with an accuracy of about 1 in. by means of microscopes and micrometer screws.

In order to ascertain whether the piers, with the instruments suitably fixed thereon, remained absolutely stationary during the period of observation, a very accurate triangulation was made before and after the deflection measurements on the dam. For this purpose, a number of fixed targets had been set in the rock at a distance from the dam and at such points that could not possibly be affected measurably by the pressure of the dam or the rising water in the reservoir. It may be stated aforehand that within an accuracy of observation of about four thousands of an inch, this check triangulation proved the position of the Piers I and 11 to be the same for reservoir empty and full.

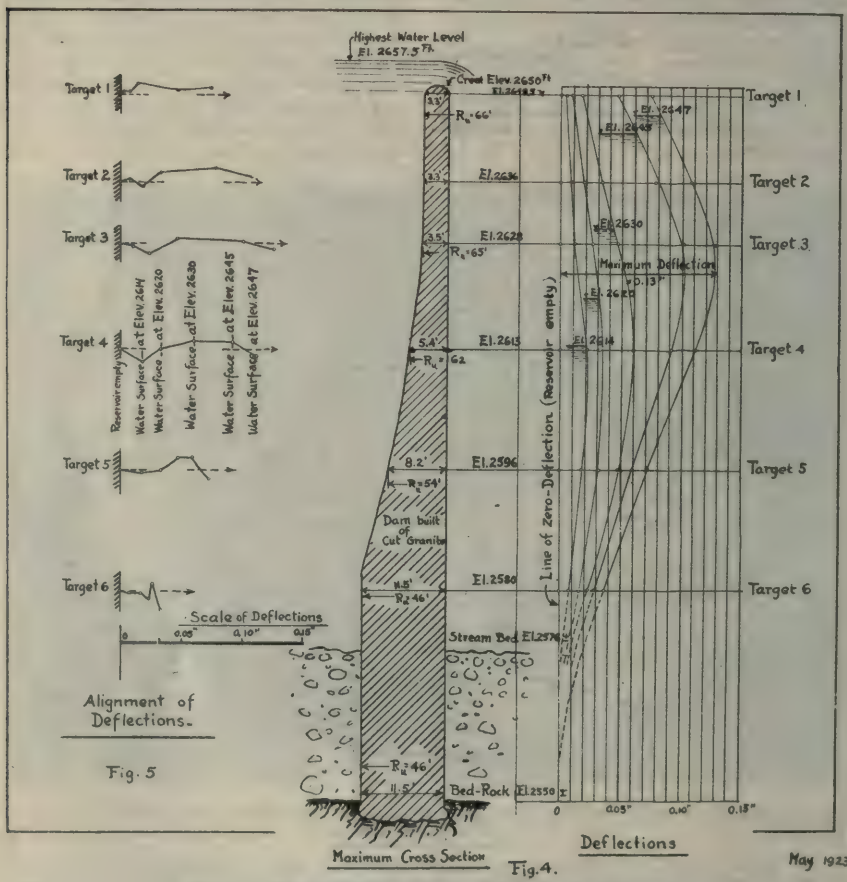

Fig. 4. Cross Section of Dam and Deflection Lines.
Fig. 5. Alignment of Deflections.

Observations.—On July 12, 1922, between 7:30 a. m. and 12:30 p. m., the water in the river was allowed to back up against the dam for the first time. By means of gates of ample capacity the water level in the reservoir was kept more or less stationary at various elevations and for about half hour intervals, during each of which a series of observations was

made for determining the deflection of the dam for the respective depth of water in the reservoir.

In addition to the deflection measurements by "intersection," the movement of the arch crown was directly observed by means of a theodolite set on Pier III. An accurately graduated measuring scale was set horizontally on top of the dam near the arch crown, and the deflection of the arch relative a line of sight between the theodolite on Pier III and a fixed target on the opposite hillside was read on this scale. These alignment measurements checked very well the corresponding deflections of the crest arch as determined by "intersection."

Calculation of Deflections. — As stated previously, special triangulation measurements proved that the observation piers were not subject to any measurable dislocation under the influence of the rising water in the reservoir and of the corresponding pressure of the arches upon the side abutments. From each series of deflection measurements made when the water in the reservoir stood at a certain level, the angle between the line I—II and the sights to the targets from each pier was obtained. The changes of these angles in seconds relative the initial size of the angles for empty reservoir were obtained, and the apparent linear movement of the targets in a perpendicular direction to the lines of sight were calculated. Fig. 3 shows how the movement of a target was then obtained graphically. As an example, the determination of the deflection of Target 3 for the water surface at Elev. 2647 is given. The distance between Piers I and II (95.5 ft.) was platted to a suitable scale, and the location of the Target 3 for reservoir empty was obtained by laying off the calculated lengths of the sides I-3=44.5 ft. and II=3-64.2 ft. The readings of the angles showed that for the water surface at El. 2647, the Target 3 had been moved by 42.0 in. as observed from Pier I, and by 30.8 in. as observed from Pier II. Both movements were in a down-stream direction. The linear movements perpendicularly to the line of sight were then readily calculated at 0.109 in. and 0.115 in. respectively. By drawing a line parallel to I-3 at a distance of 0.109 in., and another line parallel to II-3 at a distance of 0.115 in., the location of the Target 3 after deflection was obtained at the point of intersection of these two lines. In this manner the movements of all the targets were determined.

Deflection Lines.—Figure 4 shows the deflection lines of the dam for five different depths of water in the reservoir. The deflections were platted horizontally from a vertical so-called "line of zero-deflection which represents for this purpose the location of the targets when the reservoir was empty.

In Fig. 4a is given the alignment of the deflections as they occurred approximately in horizontal planes.

Discussion of Results.—The deflection measurements on this dam were made with a particularly high degree of accuracy. The instruments, methods of measurements, etc., and the observers were of the highest class, and it was estimated that the probable error of the measured deflections is not more than 0.004 in. The deflection curves are comparatively regular, and at the base of the dam they appear to go smoothly over into the line of zero-deflection as a tangent, thus indicating elastical cantilever action such as assumed in the design. The bed-rock seems not to have moved any measurable amount, and the dam may therefore be considered "fixed" at the base. The linear size of the deflection is very small (0.13 in. at a maximum) owing to the short radii of the arches and also on account of the fact that the dam is built of cut granite.

It is intended to repeat the deflection measurements at a later date and under different temperature conditions. The instruments, piers, triangulation points, etc., and the targets on the dam are permanently secured in place, and any slight dislocation due to the "time factor" or other causes could therefore be detected by such future measurements.

A description of the deflection measurements on this dam is given in "Schweizerische Bauzeitung," Jan. 20, 1923.

Water Supplies in California.—Approximately 50 per cent of the 253 municipalities in California depend solely upon underground water and 15 per cent are partially supplied from such sources. There were also in California in 1920, according to the last U. S. census, 26,800 irrigation wells with a total capacity of 10,900,000 gal. per minute.

Watershed Protection for Public Supplies

Progress Report of Committee Presented at Annual Convention of American Water Works Association

Watershed protection is viewed quite differently in the several sections of the country owing to the striking variations in local conditions, such as size of watershed, extent to which the watersheds are exposed to transient and permanent population, physical condition of the watershed, extent to which the supply is impounded and particularly as to whether or not purification is used. It became quickly apparent, in order to bring coordination of viewpoints and to set forth topics on which discussion might be advantageously held, that it is essential to call attention at the outset to different types of watersheds from which public supplies are derived. We point out four main types as follows:

1. Relatively large watersheds where conditions are such as to require filtration.

2. Very small watersheds, uninhabited and controlled by the waterworks authorities and where there is little or no storage in impounding reservoirs.

3. Watersheds with storage reservoirs large enough to hold the average runoff of many months or a year or more.

4. The intermediate type of watershed, relatively small, exposed to pollution, where filtration is not adopted and where geological and other conditions are such that a moderately satisfactory water supply is procurable in the absence of filtration, provided that the protection of the watershed is given due care.

In this present report, attention is particularly directed to that intermediate type of watershed mentioned above as Type 4, on which there are many topics which may be advantageously discussed by the members of the association, as follows:

1. Ownership of watershed.
2. Physical character of watersheds and water courses.
3. Data on water-borne diseases.
4. Elimination of nuisances.
5. The laboratory as an aid in watershed protection.
6. Needed legislation to provide authority for watershed protection.
7. Means of enforcing needed regulations.

We will outline briefly prevailing views on each of the foregoing topics, paying particular attention to points upon which there is unanimity of opinion and also noting those where there are variations in prevailing practices and viewpoints. On these subjects the committee greatly desires to secure the benefit of views of members of the association, particularly where such views are based upon practical experiences.

Ownership of Watersheds. — The purchase of much or all of the land on the intermediate type of watershed is seldom negotiable. Even where this step has been taken it does not afford protection against trespass, except in rare circumstances where the area is isolated or where patrol is unusually effective. It must be remembered that overconfidence on the part of water users may exist because they do not realize that the occasional trespasser or careless patrolman may bring about pollution thought to be impossible.

On the basis of specific merit, this question of purchase of watershed becomes essentially one of whether the investment is worth while. This in turn depends largely upon whether or not the area may be maintained in a much more sanitary condition if owned by the waterworks authorities, than would be possible if the area were privately owned. Generally speaking, purchase of the land of a watershed is not worth while, except in instances where the land is very cheap or where it is highly important to eliminate objectionable conditions which cannot otherwise be brought under control.

Experience in handling watersheds shows that ownership of land becomes less and less practicable as the size of the watershed increases. Investments in land have been found to approach the cost of investments in large storage reservoirs or more

particularly in filter plants, and the protection from the latter is greater than that derived from attempts to depopulate many watersheds. Furthermore, it is only a question of time when the vast majority of all surface water supplies will require filtration in order to secure a water of satisfactory appearance and reliable hygienic quality at all times. When filters are adopted, land purchases are not as a rule found to be good investments and money so applied might better have been put into a fund and allowed to accumulate for meeting the expense of filtration.

This general viewpoint is not without its exceptions which apply more particularly to the small watersheds and to the economic aspects of whether efficient protection of the catchment area may be assured by land purchase to an extent sufficient to justify such a step. When the step has been taken, its effectiveness is continually dependent upon the program of watershed control, which involves both the enactment of adequate laws and the efficacy with which the laws are enforced.

Marginal strips about reservoirs are sometimes purchased in inhabited watersheds to prevent easy access to the shores or to allow the most advantageous relocation of roads. They are of doubtful value as a means of reducing pollution in the majority of cases and sometimes serve to instill in the minds of the water consumers a false idea of security.

Physical Character of Watersheds and Water Courses.—The contour, geological formation, shape and location of a watershed have considerable bearing upon the effectiveness of the various methods of watershed protection. Precipitous, rocky areas unsuited to cultivation often give opportunity for protection by land purchase. The majority of watersheds include flat valleys and gentle slopes suited to cultivation so that the land is valuable in proportion to its nearness to a center of population. Land purchase is prohibitive and the wastes from the inhabitants of the watershed must be cared for in the most effective manner. In these circumstances, the geological formation of the area, together with the absence of existence of freezing conditions during part of the year are factors in determining the extent of natural purification of the polluting materials.

Porous sandy soils of considerable depth act as filters for polluted wastes entering them. In northern climates they may be robbed of their usefulness in winter by the freezing and ice coating of the surface, so that filth discharged on the ground may be washed long distances into streams, but where freezing temperatures are infrequent and of short duration, the water from a sandy area may be kept free from gross pollution. Exceptions are found where the sandy covering is thin and the underlying material is seamy or porous rock or coarse gravel.

Where the surface soil is impervious, filth deposited on the surface either directly or by overflowing receivers will find its way into water courses to a certain extent at all times and in great concentrations during heavy rains. If seamy rock or coarse gravel layers exist close to the surface, wastes from privies and cesspools entering them directly will flow rapidly with little purification underground to the stream courses.

Enough has been outlined above to demonstrate the inadvisability of formulating general rules for watershed protection for all watersheds. While leaching cesspools and privies are efficient means of disposal in deep sandy areas, they will overflow in impervious soils and will directly pollute streams where access is obtained to seams in rock or large voids in gravel. Such a general set of rules might be needlessly stringent for one area and hopelessly inadequate for another.

Data on Water-Borne Diseases.—The early detection of water-borne diseases on a watershed is an important duty of the watershed police. Immediate steps should then be taken to secure safe disposal of all wastes from the house sheltering a patient, and vigilance should be exercised to see that the special sanitary precautions are carried out until all traces of the disease have disappeared. The history of each case should be recorded with evidence as to source of infection and if other inhabitants of the watershed were known to have been exposed to the suspected source their health should be reported daily until the expiration of the maximum incubation

period (about three weeks) and steps should be taken to compel their use of facilities provided for safe disposal of excreta and urine.

The relatively long period of incubation of typhoid fever and the persistence of the bacteria in the discharges after convalescence, together with the development of occasional carriers, are factors which limit the effectiveness of attempts to check the spread of infection. The most that can be done along these lines is at best no more than half-way protection, but even this is well worth all that it costs for all unfiltered surface supplies.

Elimination of Nuisances.—For isolated residences or small communities in seamy rock formations, watertight privy vaults of approved design should be used. The soil should be removed regularly to a safe point for burial or deposition on the land. Sewage in chemical tanks or equivalent appliances should be disposed of in a similar manner. Water carried sewerage should be prohibited as far as possible and, if allowed, the sewage should be purified to the highest possible degree before being discharged into a stream. Sedimentation tanks followed by intermittent filtration and chlorination have proved effective.

If the soil is sandy and deep, leaching privies properly protected against surface wash may be allowed in locations reasonably remote from water courses. Septic tanks with subsurface irrigation or cesspools may be employed in approved locations for disposing of water carried sewage from isolated residences and broad irrigation on suitable land may be used for sewage from small communities or institutions.

When all things are done that can be done to minimize pollution from isolated residences and communities, there still remains the pollution from casual frequenters of the watershed traversing it on foot, in trains or by automobile on the highways. No measures now in force are thorough in preventing pollution from such sources, although intensive educational campaigns supplemented with frequent signs to notify strangers that they are on the watershed of a public supply may tend to reduce it. The locking of toilets on trains crossing some watersheds greatly reduces the danger from them, but this measure cannot be enforced at all times.

Proper disposal of garbage, the elimination of leachings into streams from manure piles and barn yards and the purification of wastes from creameries, cheese factories or other industrial enterprises on a watershed are important in safeguarding the purity of the water supply. Disposal of garbage should be of such character as to prevent it from being thrown into water courses or placed upon the ground in such a way that it may be washed into them by heavy rains. Manure piles should be placed where leachings from them will soak into the ground, thus conserving their value as fertilizer and preventing the pollution of the stream. Disposal plants should be installed to clean up the wastes from industrial enterprises on the watershed.

Where the amount of sewage is considerable, it should be carried to a central disposal point where works should be built and operated to produce adequate purification. Where the physical character of the ground is such that leachings from privies and cesspools would find their way rapidly into stream courses, it is sometimes advisable to sewer completely a small community, furnish it with a water supply and to carry the sewage to a central disposal plant of this character.

In attempting to eliminate nuisances on a watershed, all of the money available for this purpose should be spent first in removing gross pollution. It would avail little to build and maintain signs designed to prevent pollution from individuals traversing the area, while the discharge of raw sewage from a community into the supply were allowed to continue. The effectiveness of watershed protection depends largely upon the ability of the authorities to apply the money in directions which will actually give the greatest results.

The Laboratory as an Aid in Watershed Protection.—In a number of the larger cities, the unfiltered water supplies are controlled to better advantage as a result of current data from water laboratories than would otherwise be the case. This results not only from tests at frequent intervals to show the extent of pollution at points known to be open to pollution, but also from tests of water in streams feeding reservoirs

as well as the water in reservoirs themselves, which furnish considerable information of practical value in maintaining the supply in a condition moderately free from color, turbidity, tastes and odors.

The vast majority of water supplies are not subjected to frequent analyses in the laboratory of the water department, although a great deal of aid is secured from the analyses made from time to time of samples sent to outside laboratories, especially those of State Departments of Health or of State Water Surveys.

In instances where the aid of the laboratory may be secured only infrequently or perhaps not at all, it is important that those in charge of the water supply which is not filtered should make an unusual effort to derive full benefit from frequent, careful inspection of various conditions on the watershed related not only to pollution, but to matters associated with the appearance of the water and its tastes and odors.

Needed Legislation to Provide Authority for Watershed Protection.—A great many of the states and provinces have adopted acts of the Legislature prohibiting the pollution of streams from which public water supplies are derived. Such statutes are founded upon the police powers of the sovereign states and procedures are set forth whereby the State Department of Health takes jurisdiction in carrying out steps under various local conditions.

There is a wide variability in the laws of different states and there is need of variability as to rules and regulations depending upon the local conditions of particular watersheds. This is shown by the fact that different rules and regulations have been set forth in some particulars by the same state health authority, as for instance, in Massachusetts, where numerous sets of rules have been promulgated.

The committee finds that it is out of the question at this time to attempt to unify statutory regulations in the different states, although there is a great deal that may be done towards coordinating and improving the practical accomplishments which come from state regulation.

It is only necessary here to point out that fishing and bathing are prohibited in some supplies even where filters have been adopted, while in the instance of unfiltered supplies elsewhere, bathing and boating are permitted by definite enactment.

The influence of this association should be directed toward the restriction by statute of all activities tending markedly to pollute unfiltered water supplies and those tending to pollute filtered water supplies to such an extent as to overload or to threaten to overload seriously ordinary purification processes.

Another point upon which the position of this Association should be made clear is that statutory procedures and the regulations promulgated by health authorities should carry with them a practical and effective program for punishing those who violate the rules made in the interests of public health. That is to say, it is of comparatively little benefit to set up statutes aimed to protect the purity of inland waters and to follow them with rules and regulations as a guide to local authorities in proceeding under such statutes, if those in charge of the water supplies have no ready effective means of punishing all who offend the rules and regulations. Obviously, a law or a rule which may be broken with impunity is no better than no law at all.

Means of Enforcing Statutes and Regulations Aimed to Protect Water Supplies.—This question has two aspects. One relates to the establishment of what may be termed police patrol or inspectors on a watershed, and the other deals with procedures for punishing those who violate the rules. The latter question is one on which the Committee desires to secure experiences from members of the Association, because it is believed that the arm of the law has not ordinarily been of great help to those in charge of the protection of water supplies. It is too easy to circumvent the provisions of the law and actions in courts, dragging along for months and years, have produced a spirit of indifference on the part of the residents of a watershed. They learn that they are not likely to be punished severely by any court or jury resident in the vicinity and their humane interests in the water users of a neighboring city are remote in comparison with their own individual wishes and time honored customs.

As to the means of patrolling the watershed to guard it against objectionable pollution, the best procedure

is not capable of ready definition. Some prefer to use residents of the locality who will talk tactfully the language of the district and will do a great deal of good in restricting gross pollution. Others who are connected with the watersheds of larger cities favor police patrol with men mounted and uniformed and equipped with authority to enforce the law.

All measures of preventing the pollution of water supplies that are used or may be used without involving unreasonable costs are well worth while, but are not thoroughly effective even when the entire watershed is owned. They should be carried out thoroughly in an attempt to maintain the greatest possible degree of purity in supplies which are drawn unfiltered, but where filtration is provided the steps taken to control the quality of the raw water may be satisfactorily and most economically directed toward the elimination of gross sources of pollution.

Tests of Value of Sludge As Fertilizer

Growing tests of sludge from the sewage disposal plant of Milwaukee, Wis., were conducted in 1922 at state experimental farms at Hancock and Marshfield, Wis., and at the Wauwatosa Farm, to determine its value as a fertilizer. The results are summarized as follows in the recently issued 1922 report of the Milwaukee Sewerage Commission, of which T. Chalkley Hatton is chief engineer.

The soil at Hancock is of a decided sandy quality, whereas that at Marshfield is heavy clay. The Wauwatosa Farm has a friable soil of good quality, capable of growing the ordinary plant with little fertilzer.

Five hundred pounds of dried sludge, just as it came from the dryer, was delivered at each place. At Wauwatosa it was used in comparison with other fertilizers, each having the same quantity of ammonia, potash and phosphoric acid. These different fertilizers were used for growing oats, beets, onions and corn. No actual measurements were made of the results, but judging from the eye during the growth, no difference could be detected between the yield from any of the fertilizers.

At Marshfield, F. L. Musbach, superintendent in charge, used the sludge for growing of silage. In one case, he used 175 to 200 lb. of what he calls a complete fertilizer, with a mixture of 2-10-4 (2 phosphoric acid, 10 nitrogen, 4 potash), in another a sodium nitrate containing the same amount of nitrogen as was in the sludge, that is, a total of 8 per cent, 4½ per cent of which was available, and in the other case, the sludge was used.

The plots were one-fifth of an acre, and the result was as follows:

Complete Fertilizer	3120 lb. corn silage
Sludge	2710 lb. corn silage
Sodium Nitrate	2860 lb. corn silage

At Marshfield, Prof. A. R. Albert in charge, made much more extensive investigations, both at his farm and at that of a neighboring one, called the Malthe Farm.

The test at the Hancock Farm was made on corn and potatoes, and the yields of corn are recorded on the dry basis:

Plot	Treatment	Corn (grain) Bu. per A.	Corn Stover Lbs. per A.	Potatoes Bu. per A.
44	P.-K. only	23	1888	61.3
50	P.-K. plus 150 lb. Nitrate Soda	24.3	1615	58.7
54	P.-K. 1000 lb. Sludge	30.8	1488	98.7
55	P.-K. 50 lb. Dried Blood	29.5	3020	102.7

To supply P. 100 lb. treble superphosphate per A. were used. To supply K. 150 lb. of muriate of potash were used.

At the Malthe Farm the following records were obtained:

Plot	Treatment	Corn (grain) Bu. per A.	Sudan Grass Lbs. per A.	Potatoes Bu. per A.
1	150 lb. Dried Blood plus 300 lb. O-12-4	25.7	2490	104.4
2	150 lb. Nitrate Soda 300 lb. O-12-4	20.3	2378	64.3
3	Only 300 lb. O-12-4	18.3	1415	80.2
4	Activated Sludge plus 300 lb. O-12-4	19.1	2255	71.2

The soil on which these two tests were made is known as Plainfield sand, deficient in fertility and subject to drouth and winds.

Method of Lowering Tank Into Deep Pit.—A novel method was used in lowering of a large tank into a deep pit, without any tackle, to serve as an oil reservoir for a power plant. According to the Contract Record the concrete pit was filled with water and the steel tank simply rolled in. It naturally floated on the surface of the water, which was then pumped out, allowing the tank to settle to its proper seating.

Concrete Lining of Irrigation Canals and Laterals

Costs and Economic Advantages on Orland Project, California, Given in the Reclamation Record

By R. C. E. WEBER,
Project Manager, Orland Project of U. S. Reclamation Service

At the conclusion of work of placing concrete lining for the season of 1922-23, there had been placed 755,400 sq. yd. of lining on 79.8 miles of the canals and laterals comprising the distribution system of the Orland project. The first work performed during 1911 in this connection consisted of lining several high fills on the High Line Canal and various sections, also in fill, of laterals located in fertile black sandy loam, where plant growth was so luxuriant as to require cleaning several times during the irrigation season in order to permit regular water deliveries. The work first performed was limited in extent, but was followed by expenditures from revenues of the original construction charge of the project, which provided for lining about 30 miles of distributary channels. The results of the lining thus placed were so satisfactory that, with the realization of inevitable high maintenance costs unless a comprehensive program of lining was adopted, the Orland water users in 1917 entered into a supplemental agreement with the Secretary of the Interior, agreeing to an increased building charge of $11 per acre to be expended in placing concrete lining. Construction under this supplement agreement was subsequently commenced and has since been prosecuted each winter season, the work being performed after the close of the irrigation season in the fall and prior to its beginning in the spring. There still remain unexpended from the supplemental revenue sufficient funds for lining 10 miles of laterals, so that at the conclusion of the supplemental work 90 of the 148 miles, or 60 per cent, of the project distribution system will be lined with concrete.

Mixing and Placing Concrete for Lining Irrigation Canal of Orland Project.

Maintenance Costs of Earth and Concrete Lined Sections.—Comparative costs of maintaining the earth and concrete-lined sections are available covering a season's work of cleaning 66 miles of the former and 31 miles of the latter, from which is obtained a cost of $55.70 per mile for earth and $19.50 for concrete-lined sections. The data apply to laterals

of an average capacity of 25 second-feet. A reduction of 65 per cent in the maintenance cost of earth laterals results from the use of concrete lining, and this may reasonably be expected to increase as the system is more and more comprehensively lined. The work of cleaning earth sections is performed with teams and scrapers and consists in the removal of silt de-

Finishing Concrete Lining.

posits and all plant growth. The maintenance work in connection with lined sections consists of the removal by hand of the small slit deposits and of making minor repairs to the lining.

Reduction of Seepage and Evaporation.—A reduction in seepage and evaporation losses is an additional factor in favor of the concrete-lined section. By means of current-meter measurements and discharges over weirs, seepage and evaporation losses of laterals located in the different soil types of the project and in concrete-lined sections have been determined during each irrigation season from 1912 to 1922, the means of which are tabulated as follows:

Type of section	Loss in feet per day of unit of wetted perimeter.
Concrete lining	0.29
Clay	.63
Gravelly clay	1.38
Loam	1.40
Gravelly loam	1.47
Sand and gravel	2.85

From the foregoing tabulation a material reduction in seepage and evaporation losses (as much as 90 per cent in sand and gravel sections) is possible by the application of concrete lining to the earth section. Another important factor in favor of the concrete-lined section over the unlined channel in earth is that of the increased degree of operating safety as a result of the comparative freedom from washouts and breaks, with the consequent expense for repairs and possible great crop loss resulting from an interruption to regular water deliveries.

The irrigable area of the project is 20,500 acres, of which 15,000 acres were under irrigation during the season of 1922 and which was all served, either directly or indirectly, through concrete-lined channels. With the exception of about 4,000 lin. ft. of the South Canal (which it is deemed impractical to line on account of winter ground-water conditions), all the canals on the project distribution system, together with all laterals of capacity in excess of 25 second-feet, have been concrete lined. There remain unlined, therefore, only laterals

Irrigation Canal Lined With Concrete.

of less than 25 second-feet capacity, and these consist mainly of secondary laterals or constitute the extremities of primary laterals where water is delivered only intermittently on the regular rotation periods.

Cost of Concrete Lining.—The cost for all concrete lining placed on the

distribution system of the project is 38.9 cents per sq. yd. for 755,400 sq. yd. placed on 79.8 miles of canals and laterals with capacities varying from 10 to 225 second-feet. The period of time over which this cost was incurred extends from 1911 to 1923, during which there has been a large variation in price of materials and wages of labor, as illustrated by the maximum of $4 per day of eight hours for labor in 1920 to a minimum of $2.24 in 1911.

Cost of Concrete Lining Placed During Season of 1922-23, Orland Project

Item of Cost	Total cost	Cost per square yard
Preparing section for lining	$ 5,914	$0.076
Cement (including hauling to field)	10,129	.130
Gravel	3,921	.050
Mixing	1,944	.025
Placing	3,253	.042
Finishing	414	.005
Sprinkling and protecting	130	.002
Water	327	.004
Repairs and supplies	227	.003
Equipment charge	365	.005
Total labor and material cost	26,674	.342
Superintendence	177	.002
Engineering	509	.007
General expense	3,498	.044
Total overhead cost	4,184	.053
Total cost	30,858	.395

Quantities

Item	Unit	Quantity	Cost per unit
Lining	Square yard	77,919	$0.395
Concrete	Cubic yard	2,882.7	10.70
Lateral lined	Mile	9.05	3,410
Do	Linear foot	44,776	0.646

Thickness of lining, 1½ in.

Average haul: Gravel, 1¾ miles; cement, 4¼ miles.

Labor costs per day: Finishers, $4.75; placers, $4; laborers, $3 to $3.50; teamsters with 2 horses, 5.50.

Cement (at project warehouse), 2.80 per bbl.

Section lined: Bottom width, 3 to 15 ft.; vertical height, 1.5 to 4.75 ft.; side slopes, 1½ to 1 and 2 to 1; capacity, 15 to 75 second-feet.

With labor and material prices as those prevailing prior to 1916, concrete lining has been placed at a cost of 34.3 cents per sq. yd., 27.8 ct. of which was for labor and material and 6.5 ct. for overhead charges, consisting of general expense, engineering, and superintendence. The average labor wage for lining placed at the foregoing cost was $2.50 per day for laborers and $4.50 for teamsters with two-horse teams. Cement cost was $2 per barrel. As there is little hope to be entertained that prices in the near future for labor and materials will approach the foregoing low figures, the detailed analysis above is submitted for the cost of lining placed during the season of 1922-23 with a view of illustrating probable costs for future work of this nature.

Durability of Lining.—With regard to the durability of lining of 1½ in. thickness without reinforcement it can be said that lining placed in 1911 and in continuous use each irrigation season since is still in excellent condition, with no indications of disintegration or failure. The mild California winters in the Orland vicinity, where temperatures reach only a minimum of 21° above zero, make possible the use of an extremely thin slab of concrete for lining purposes.

Concrete Lined Irrigation Canal.

New Irrigation Project in India.—A big irrigation project is being planned for the Gwalior Durbar—Central India—by the Durbar's own Irrigation Department. The Maharajah Scindia of Gwalior is taking a personal interest in the project which, it is stated, will cost about 300 lakhs of rupees. The object is to bring under cultivation many hundred square miles of fallow land by the damming of the Chambal and a few other rivers which flow through the Gwalior State. It is understood that the Maharajah intends to spend about 60 lakhs of rupees on this project in the ensuing year.

Double Coagulation in Water Filtration

Experiences at Portsmouth, O., Described in Paper Presented at Ohio Conference on Water Purification

By F. E. SHEEHAN
Superintendent of Filtration, Portsmouth, O.

Portsmouth uses double coagulation of the filtration process to treat the badly polluted Ohio River water used as the source of public water supply. Double coagulation is accomplished with two settling basins operated in series, the water entering each receiving a dose of coagulant. The practice of double coagulation is not entirely new to water works practice, for it is being used regularly in several of the western water purification plants that treat very muddy and highly polluted waters. So far as is known, however, the Portsmouth plant is the first one in Ohio or in this section of the central states to have employed the practice regularly.

The Filtration Plant.—The city of Portsmouth has a population of about 40,000 and is located on the Ohio River at the confluence of the latter stream with Scioto River. The source of public water supply is Ohio River, the intake being located just above the city. A rapid sand filtration plant of eight million gallons daily capacity was installed in 1915. As originally laid out the treatment included plain sedimentation in a settling basin of about eight hours' retention, followed by a coagulation in a three-hour secondary basin. The filters are of the New York Continental Jewell type, low rate wash water with air agitation, eight in number and having one million gallons capacity each. The plain settling basin was designed with horizontal baffles arranged for over and under flow or vertical travel of the water through the basin. The coagulants used at first were sulphate of iron and lime. These were later changed to sulphate of alumina, assisted by lime at times.

In 1918, changes were made in the construction of the plain sedimentation basin at the suggestion of the State Department of Health. The baffles were rebuilt to cause horizontal travel of the water instead of vertical, the water passing around the ends of the baffles. At the same time the coagulant lines were laid so that the settling basin now became a primary coagulation basin.

Condition of Ohio River Water.—The extent to which water treatment is necessary at Portsmouth may be gained from a study of the analytical results of the past six years. On an average, the Ohio River carries a turbidity of about 160 and may reach a maximum of 2,000. Bacteria per c.c. at 20° C average about 6,000, but may reach as high as 100,000. B. Coli per 100 c.c. averages about 2,000, but may reach as high as 15,000. Successful clarification of the water has not been obtained heretofore, except with the assistance of chlorination. Since the installing of double coagulation the filters have been able to produce a water of satisfactory bacterial quality without the assistance of chlorination and comparing favorably with the standards of the State Department of Health for unchlorinated filter effluent.

In Table II are given figures showing the performance of the Portsmouth Water Purification Plant during the year 1918 when single coagulation was used and during the year 1922 when double coagulation was

Table I—Comparison of Operating Results Using Single Coagulation During February, 1918, With Results Using Double Coagulation During March, 1922

	Coagulants Used (Grains per Gal.)		Percent Wash Water	Turbidity (P. P. M.)			Bacteria per CC. @ 20° C.					Presumptive B. Coli (Percent Positive)			
												Filtered		Disinfected	
	Alum[2]	Lime		Raw	Primary Basin	Secondary Basin	Raw	Primary Basin	Secondary Basin	Filtered	Disinf.	1 cc. %	10 cc. %	1 cc. %	10 cc. %
February, 1918—(Single Coagulation)	1.7	1.6	3.5	344	290	57	20,000	17,000	6,000	425	[illegible]	50	90	25	25
March, 1922—(Double Coagulation)	1.1	0	1.5	225	29	12	16,200	3,900	2,340	100	0	0	3	0	0

regularly employed. Table I compares the results of plant operation for the month of February, 1918, with the month of March, 1922. During these months the raw water had very similar characteristics; in 1918, however, plain settling was used for the preliminary treatment, whereas in 1922 double coagulation was used. The conclusions to be drawn from a careful perusal of the figures given seems to be as follows: The total amounts of coagulants used during the period of double coagulation is less than the total amounts of coagulants used during periods of plain sedimentation followed by single coagulation. It is further noted that the clarification by the preliminary treatment processes was greatest using double coagulation; that the removal of bacteria was by far greater using double coagulation; that the wash water required was 50 per cent less with double coagulation; that the filter effluent was of satisfactory sanitary quality without assistance by chlorination when double coagulation was used.

It has been observed that a better reaction of the coagulant seems to obtain when the dose is divided into two portions such as is the case with double coagulation; the water entering the secondary coagulation basin seems to be in a more receptive condition for the reaction to take place and the character of the floc thus formed is much more satisfactory. Ease of operation is afforded by the double coagulation practice, for the operator can use as an index of raw water conditions the effluent from the primary coagulation basin; sufficient leeway is given for shifts in quantities of chemicals applied such that the influent water to the filters may be held of almost uniform character.

Experience at Portsmouth would indicate that double coagulation is particularly applicable to those raw waters having a highly polluted character subject to rapid changes. In the past it has been impossible to obtain a plain filter effluent approaching satisfactory sanitary quality chiefly because influent water to the filters carried high turbidities and a high bacterial content. It is now possible to control the influent to the filters to an average turbidity of less than 35 and to an average B. Coli content of less than 100 B. Coli per 100 c.c. Experience at Portsmouth further indicates that such water may be filtered readily to obtain the standards desired in plain effluent before chlorination.

Conclusions.—Advantages of double coagulation are: (1) Less total coagulant is required to obtain equal or better results as measured by clarification and removal of bacteria. (2) A highly polluted raw water may be treated more successfully and still have the effluent from the filters substantially equal the most rigid bacterial standards. (3) Ease of operating control is established much more satisfactorily if two entirely separate coagulation basins are installed in series operation. (4) The character of floc obtained in influent water to the filters, so important to good filtration, seems to be improved by dividing the dosage of coagulant into two distinct steps in the process. (5) A primary coagulation basin more than fulfills every duty of performance of a plain sedimentation basin and is much cheaper to construct than a plain sedimentation basin on account of reduced capacity needed.

Table II—Comparison of Operating Results Using Single Coagulation During Year 1918 With Results Using Double Coagulation During Year 1922

	Coagulants Used (Grains per Gal.)			Turbidity (P. P. M.)			Bacteria per CC. @ 20° C.					Presumptive B. Coli (Percent Positive)			
												Filtered		Disinfected	
	Alum[2]	Lime	Percent Wash Water	Raw	Primary Basin	Secondary Basin	Raw	Primary Basin	Secondary Basin	Filtered	Disinf.	% 1 cc.	% 10 cc.	% 1 cc.	% 10 cc.
Year 1918 — (Single Coagulation)	1.4	0.9	3.2	144	90	38	5,800	.....	.....	....	120	23	68	15	54
Year 1922 — (Double Coagulation)	1.4	0.1	1.7	163	24	10	6,200	1,800	1,000	84	8	0	13	0	0

[1]Double coagulation placed into regular use May, 1919.
[2]Iron sulphate used instead of alum greater part of year 1918.

Form for Keeping Records of Water Services

A form designed to facilitate the keeping of records of water services, where the consumer or property owner pays the cost of them is illustrated below. As will be noted the form is a combination of consumer's application, foreman's work order and report of work. The form was prepared by Ray S. Blinn, while Director of Public Service of Coshocton, O.

CITY OF COSHOCTON, OHIO WATER DEPT.

APPLICATION No. . . . . .

Coshocton, Ohio 19

Premises Located at No. . . . . St.

The undersigned hereby makes application for items as checked below: √

	City Water Service ON	
	Discontinue Service OFF	
	New "line main to curb	
	Replacing old line with "	

Pipe to enter curb at . . . . . .

	Line: Change location : Meter	
	Line: Temporary use : Meter	
	Line: Cleaning out : Meter	
	Line: Repairing : Meter	
	Line: Removing : Meter	
	Deliver : Meter Set	

and declares that he is the owner of property within the city and will GUARANTEE to pay all expense incurred for labor, material or other incidental work upon demand, all in accordance with the rules and regulations now in force in the City of Coshocton and Water Department.

. . . . . *Applicant*

Size of line . . . . . *Size of main* . . . . . .

Pipe enters curb at . . . . . .

Distance main to curb box . . . . . *ft.*

Location of cut-off valve supplying main . . . . . .

Memoranda

CITY OF COSHOCTON, OHIO WATER DEPT.

FOREMAN'S WORK ORDER AND REPORT OF WORK No. . . . . .

Coshocton, Ohio, ... 19

Premises Located at No. . . . . St.

Work	*On Items Checked* √	*Done*
	Turn Water ON	
	Turn Water OFF	
	New " line main to curb	
	Replace old " with "	

Pipe to enter curb at . . . . . .

	Line Change location Meter	
	Line Temporary use Meter	
	Line Cleaning out Meter	
	Line Removing Meter	
	Line Repairing Meter	
	Deliver Meter Set	

FLAT		*METER*	
Gen. Purpose		*Size*	*No.*
Bath	*W.C.*	*Make*	
Motor	*Sprinkle*	*Reads*	

Remarks

Mail bills to

MATERIAL EXPENSE		*SERVICE LINES*	
Quantity	*ITEM*	*Price*	*Amount*
	" galv. ser. pipe		
	" Corp. cock		
	" Stop cock		
	" Stop box		
	" Nips		
	" Elbows		
	" Unions		
	" Tees		
	" Couplings		

LABOR EXPENSE			
Hours	*No. of Men*	*Rate*	*Amount*
	Foreman		
	Laborers		

OTHER EXPENSE		
	1 TOTAL TAP CHARGES	
	2 Turn on charge	
	3 Temporary use charge	
	4 Cleaning	
	5 Repairing	
	6 Removing	
	7 Sale of Meter	
	8 Delinquent accounts	
	Total $	

. . . . . *Foreman*

Form for Water Service Application, Work Order and Report of Work.

French Plan Electric Farming

In the closing days of the session of 1923 the French Parliament passed a long advocated measure for the extension of electrical service to rural communities. More general use of electricity on the farms, it is believed, will partly offset shortage of farm labor caused by the depletion of man power during the war years. Besides household industries, now hard pressed by manufacturers in the great industrial centers, will be strengthened, thus assuring the continuance of one of the supplemental sources of income which is important in many of the departments of France, says Commercial Attache C. L. Jones in a report to the U. S. Department of Commerce. By the same means it is believed agricultural production may be increased and the general attractiveness of farm life heightened in a way which will help to check the drift toward the cities which has become even more marked since the war than before.

The general purpose of the new law is to place at the disposition of the National Office of Agricultural Credit a maximum sum of 600,000,000 francs to be employed in rural electrical development through advances of cash made to the smaller political units or associations of individuals. The detail of administration is to be provided by regulations issued by the government to supplement the terms of the law.

The Importance of Competent Investigations of Water Supply Before Commencement of Construction

Abstract of a Paper Presented at the Annual Meeting of the Illinois Section of the American Water Works Association

By ALEX. VAN PRAAG, Jr.,
of Holbrook, Warren & Van Praag, Consulting Engineers, Decatur, Ill.

Perhaps no one element is more directly responsible for the uneconomical operation and high maintenance costs, and the ultimate failure and abandonment of municipal water works stations than the failure to conduct a comprehensive and systematic study of the community's water resources prior to the construction of the water works system. By a comprehensive and systematic study of the possibilities of the chosen source of supply with respect to future extensions and enlargement; and also a complete anaylsis of the relative costs of developing the available sources of water supply, including operation and maintenance costs. The object of this paper is to discuss the value of such preliminary studies in so far as they apply to shallow ground water sources.

That an accusation of this character is based upon sound facts and is just, is evidenced by the substantial number of municipalities which from time to time entirely abandon one source of supply in favor of a newly located source, not infrequently in close proximity to the original or former source of supply.

The Effect of Local Conditions.—It is manifest, if the above mentioned preliminary studies are to be made, that one of the first and most vital determinations in the study is an assembly of the facts concerning the water bearing strata. Now, throughout certain sections of Illinois the nature of the geological structure is relatively well known and the records thereof are reasonably complete. For example, in most of our northern counties it is reasonably certain that an ample water supply of good quality is readily obtainable if wells are drilled to St. Peter or Potsdam standstone. In such a case a preliminary study requires no extensive prospective or test drillings to determine the local geological structure, but may be considered primarily, if not solely, for the purpose of ascertaining the type and probable cost of any proposed installation.

In other sections of Illinois, however, the prevailing conditions are decidedly different. In central Illinois, for example, the major number of our public water supplies are derived from shallow ground sources, more generally from water bearing glacial drift deposits. The records of drillings in one community are of little if any value to a neighboring community, and in general the records themselves are very meager. Moreover, the glacial drift is peculiarly irregular and non-homogeneous and there is no certainty of securing any appreciable volume of water until extended drillings and extensive pumping tests have been made. Under these conditions the preliminary studies in connection with a proposed water supply installation are of grade importance, for on their throughness not only depends the possibility of the installation from a financial standpoint, but also the feasibility of any installation being made at all. Still further, the reliability and operating success and the cost of maintenance in such cases is entirely dependent upon the action taken as a result of the preliminary investigation.

The Mistake of Niggardliness in Expenditure on Investigation.—All too frequently preliminary investigations of ground water supplies are not made at all or they are directed by the unqualified judgment of local persons in preference to being based upon an assembly and study of facts and data best interpreted by engineers experienced in water supply developments. It seems to be the general, mistaken impression of public officials that the first available funds should be expended at once for a part of the necessary equipment for the water works instead of using the first modest expenditure for investigation

to insure the water works installation being a permanent and economical one.

In order to elaborate somewhat on the necessity of preliminary studies and suitable test drillings the author assumes the liberty of referring to, and analyzing, the water supply history of a particular city with which he is personally familiar.

Mt. Pulaski, Ill., is a city of 1,510 population. It is built upon the peak of an abrupt hill, one of a few high points in central Illinois. The surrounding territory is quite flat and the nearest well defined watercourse is approximately 3½ miles distant.

The original water works at Mt. Pulaski were installed in 1895 and the source of supply then comprised a single well about 85 ft. in depth, penetrating fine sand, and located at the public square on the very peak of the hill. About 1907, only twelve years later, a new water works station was constructed in the southwest part of the city, the supply then being derived from three dug wells, penetrating a layer of fine yellow sand of more or less indefinite depth. Each well was 33 ft. in depth and was walled with stone. These three wells, which are still in service, are all located on a single tract of land enclosing about ¾ of an acre. Another similar well, but with a 23-ft. tubular extension in its bottom, was also located nearby and formerly was held in reserve to meet excessive demands though it later was entirely discarded as a part of the public water supply.

Since their construction these wells have ever been subject to clogging with fine sand, thereby reducing their capacities, causing undue wear on pumping equipment, and resulting in exorbitant maintenance costs. Their yields have accordingly been totally inadequate and the cause of a general restricted use of water. The restricted use of water has resulted in a general tendency to depend upon private wells, all of which circumstances of course, assist in raising the unit operating costs of the public supply.

For some time the city council has realized the necessity of improving the city's water supply resources and during the past year it was prevailed upon by its engineers to conduct a series of test drillings in the hopes of locating a more satisfactory source of supply.

The engineers outlined a systematic program of drilling based upon a study of the surrounding topography, assembled records of previous drillings, and a knowledge of the general structure in the vicinity, and the drilling program was instituted.

A series of holes were drilled progressively to the east and south along a more or less meandering line lying just south of the city, where the available data indicated a satisfactory supply was most likely to be located. As each test well was drilled samples of the drillings were collected for examination and accurate logs of the wells were drawn. The logs were platted in section to their true elevation along sections drawn through the principal lines of the drills, and an accurate plat was made showing the location of each test hole. This data not only served its purpose during the progress of the drillings, but is now a matter of permanent record.

A total of 22 test holes were drilled before a supply of satisfactory volume was located and the final location determined for a new pumping station. As a result of the drillings, however, the city has located a water bearing strata consisting of coarse sand and clean coarse blue gravel approximately 17.5 ft. in depth and lying between depths of 40 and 57.5 ft. below the surface. The deposit is under a static head of water which rises to within 14 ft. of the surface.

Before concluding the test drillings the city conducted a pumping test on an 8-in. well located at the site of one of the test drillings. The test was conducted under the direction of the Illinois States Water Survey and the State Department of Public Health. It concluded a continuous pumping of the well for 26 hours, more or less, during which time measurements of the well discharge and of the draw-down both at the well itself and at other nearby points where simultaneously recorded. It should be noted that while the draw-down when first pumping the well was marked and rapid, yet with continued pumping the water level gradually assumed a more or less permanent level and at no time was it lowered to the top of the water bearing strata.

The test data secured indicates that the city can produce from a

single well in the vicinity a sufficient supply of water to satisfy its present demand with less than six hours of continuous pumping. Heretofore the present wells have been exhausted after a relatively short period of pumping, and it became necessary to discontinue pumping until they again were replenished, and the supply accordingly has been extremely doubtful at all times.

Cost of Tests at Mt. Pulaski.—The total cost to the city for conducting the test drillings approximated $1,500 and the city is now having prepared the necessary plans and specifications for a new pumping station. This new pumping station will probably be constructed during the coming year. It makes the third water pumping station to be constructed in a period of 28 years. It is 16 years since the construction of the present station.

It should not be assumed that the Mt. Pulaski situation is an unusual one and that it did not offer its difficulties all during the period of the drilling. As a matter of fact it was necessary at the outset, in order to satisfy certain members of the city council, to drill two holes on the present pumping station lot. Both of these holes were drilled to more than twice the depth of the present dug wells and each penetrated but a negligible depth of fine yellow sand, water bearing, and thus showed conclusively that the present location is a most unsatisfactory one.

Again, after sinking some 7 or 8 holes with only moderate success the city, against the advice of its engineers, again returned to the present water works site and sunk in the immediate vicinity at least two more holes.

Also during the course of the drilling it was necessary to satisfy the demands of certain council members who have a religious belief in the unfailing "water witch."

Now it should be noted also that at Mt. Pulaski there were no visible or outstanding assurances of success in locating a satisfactory water supply if the test holes were sunk excepting the convictions of the engineers who had devoted some time and study to the local situation. To be sure, many of the first holes sunk indicated discouraging results and it was not until entire 22 holes were sunk that conditions were considered satisfactory to warrant discontinuing further investigations. On the other hand in a similar study at Witt, Ill., it was found necessary to sink but 5 holes when sufficient data were secured to warrant stopping drilling.

Savings that Might Have Been Made.—Now it is not of general interest that Mt. Pulaski has experienced particular success in improving its water supply by drilling. The Mt. Pulaski experience is discussed herein because it embraces a typical experience and illustrates the one point the author wished to impress, and that is this, by a modest expenditure for test drillings and preliminary investigations and by truly studying and investigating its water supply resources this city has located a source of water supply sufficient to warrant the abandonment of its present supply in favor of a new one. This new supply was only recently investigated, but had it been properly investigated before the preceding two water pumping stations were installed it would doubtless have made unnecessary the very large expenditure for rebuilding at least twice, and also it would have eliminated very largely the relatively exorbitant maintenance costs which have been experienced by the city for the past 28 years. Many other cities have had much the same history as Mt. Pulaski.

As engineers or persons otherwise interested in the proper development of public water supplies it remains with us to exert every effort to make sure that future water supply installations will be made based upon sound facts and not upon chance judgment. In other words, if we wish to insure proper and economical water supply installations, and assist in preventing expensive rebuilding programs, we must impress the responsible officials with the necessity of comprehensive and systematic preliminary water supply investigations directed by competent engineers. By such means only can we prevent the continued recurrence of experiences such as those of Mt. Pulaski.

Welland Canal Construction Progress.—An appropriation of $11,800,000 has been made to cover construction operations for the current year on the Welland Canal. About $34,000,000 has been expended, so far, and the cost will be $80,000,000 altogether. It is expected the canal will be completed in 1927.

Sealing Permeable Foundation of Dam With Grout

Method, Dispensing With Cut-off Trench, Employee on Small Structure in Quebec Described in The Contract Record

By W. S. LEA,
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On July 28th, 1920, a contract was awarded to the W. I. Bishop Co. of Montreal, for the construction of a dam on the Jacques Cartier River at Pont Rouge, P. Q., for F. W. Bird & Son. The company operates a paper mill there, situated on the west bank of the river, which flows in a southerly direction. The plant is operated by hydraulic power, the water wheels being located in a flume across the east end of the mill buildings, which extends into the stream and serves as a dam for a distance of about 50 ft. The natural head at the site is about 8 ft., increased in the original development to a total of 18 ft. by a low wooden dam extending from the northeast corner of the mill to the east bank. The alignment of the dam follows the crest of the rapids which cross the river at an angle running upstream from the mill. This old structure had served its time, and it was proposed to replace it by a concrete dam built across the river from 50 to 100 ft. below the wood dam, and between the mill and the east bank.

Seams in the Rock Open Enough to Carry Water.—The bed and banks of the river at the site are of rock, stratified in horizontal layers of from one inch to six inches in thickness. Most of the seams in the rock are very fine, but it was known from previous excavations in the mill basement that some of them were open enough in places to form small channels which carried water freely. There is a low section in the crest of the rapids near the east bank of the river through which practically the total low water flow used to be diverted, and in the course of time it had worn a channel about 20 ft. wide and from 10 ft. to 15 ft. deep along the east shore of the river for about 400 ft. downstream to the foot of the rapids. The mill is located about midway down the rapids and a tailrace had been blasted out of the rock along the west bank from beneath the wheel pit to the foot of the rapids. I may say that the east bank, where there was a natural tailrace available, was not suitable for a mill site.

The total flow of the river is required to supply the draft of the wheels in the low water months. Therefore when the work started in midsummer, the bed of the river for about 100 ft. or more, both above and below the site of the new dam, was exposed rock from 5 ft. to 10 ft. above the level of the tailrace; excepting of course, the natural channel into which the tail water backed and stood almost dead, the only flow through it being the leakage from the old dam.

Provision for Increasing the Height of the Dam.—The new dam has an overall length of 143 ft. and consists of 7 piers from 25 to 30 ft. high on 23 ft. centres. The piers rest on a concrete sill from 2 ft. to 3 ft. thick, except in the channel, where the depth of the sill is increased to 12 ft. and where the total height of the dam exceeds 40 ft. The intention is to eventually add 20 ft. to the height of both the sill and the piers.

The seams in the rock were exposed on the sides of the channel, a condition which was regarded as both a menace and a help so far as uplift pressure under the dam was concerned; because although it undoubtedly offered a favorable opportunity for the water to penetrate the foundation right against the heel of the dam, the chances were that it could readily escape near the toe of the dam through the seams exposed on the sides of both the natural channel and the tail race.

On the whole it will be seen that the conditions were unusually favorable for the work in hand. Our chief worry was that it was already well along in August before anything could be done, the fall rains were due in October, and the Jacques Cartier was well known as a flashy river, with a flood flow of over 25,000 sec. ft., from a water-shed of 1,100 sq. miles. The contractor could team his sand to the site from pits in the vicinity, but everything else had to be brought in by rail, the cement from Exshaw, Alta., at a cost of $6.60 per bbl. Labor and materials were both

scarce, and prices were at the peak at this time.

As intimated above, we were really building the substructure of a dam which would eventually have an average height of over 45 ft. and a maximum height of 60 ft. At current prices, the extent to which uplift pressure was provided against in the design was an important factor affecting the cost of both the initial and final structures. In the end, practically no allowance was made for uplift, apart from the eight 1⅛ in. vertical rods placed in the nose of each pier and anchored into the rock foundation. There was little to be feared from ice pressure. The river turned through a sharp 90 deg. angle immediately above the old dam and springs along the bank kept the outer shore of the bend free from ice. As matter of fact, however, our decision concerning uplift did not mean that all the bridges were burned behind us, because it was intended during the progress of the work to try and determine the maximum uplift pressure which would prevail in the foundation from the proposed future forebay level. If this could be done, or if considerable uplift pressure were found to be unavoidable, then the design of the sills in the future dam could be modified to take care of the contingency, although it would detract to some extent from the final appearance of the dam.

No Preliminary Investigation of the Foundation.—Under the circumstances attending the inception of the project, there was no opportunity to drill and test the foundation in advance of the preparation of the plans. This was one of the main reasons for letting the contract on a commission basis; there was very little about the foundation in either the plans or specifications. A concrete cut-off 5 ft. deep was shown along the heel of the dam, and it was specified that any seams below this depth would be grouted through holes drilled in the bottom of the trench to the number and depth deemed advisable after the nature of the foundation had been revealed by tests. When the work was started, it was found after shooting a couple of blasts that a cut-off trench of a reasonable width could not be provided without very close drilling. Moreover, as the rock had a tendency to shatter beyond the lines of the trench, it was decided to dispense with the cut-off and rely on grouting to seal the foundation through 2 in. holes drilled at 4 ft. centres in a row parallel to and about 2 ft. upstream from the heel of the dam. These holes, through which it was intended to both test and grout the foundation, are referred to as "grout" holes to distinguish them from "test" holes drilled in other places for testing purposes only. Steam, water, or air were available from the mill at suitable pressures for testing and grouting.

It was, of course, necessary to determine the elevations of the lowest seams in order to determine the depth to which the holes should be drilled, and also to determine the approximate area of the seams, particularly the upper seams, in order to fix a safe limit for the pressures applied in testing and grouting.

In nearly all the holes the water stood within 2 or 3 ft. of the surface, and the elevations of the lowest seam in any hole could be closely determined by exhausting the water from each hole in succession, and noting the levels to which the water dropped in all the other holes and finally came to rest. It was decided in the first place to tentatively adopt 25 ft. for the depth of the holes and since, according to the tests, seams did not appear at any hole below 15 ft. from the surface, the 25 ft. drilling was adhered to throughout. In making these tests a steam ejector was used to exhaust the water from the holes.

Determining the Size of the Seams.—We never succeed in getting a good idea of the areas and distribution of any of the seams, except that it was certain there were neither large nor continuous over wide areas. This became fairly apparent in testing for the elevations of the deepest seams. This test was, however, supplemented by others, in which water or air was applied under pressure to the seams, through short pipes cemented into the tops of the holes. Water was the best indicator of the capacity of the seams, as the rate of discharge could be easily metered in the supply line, but in attempting to determine their distribution air gave better results. Once the air was turned into a hole it was easy to detect its slightest escape at the other holes, on account of the distribution of the water standing in them, air bubbles in water being a very sensitive indicator.

Where the water carrying capacity of the seams is small it is feasible to

determine the number and elevation of the largest of them at most of the holes with but little interference with the drilling. This can be done by first drilling and inserting the nipples in say every fourth hole in the row, so that water can be applied under pressure to one or more holes adjacent to each intermediate hole as it is being drilled. The instant each interconnecting seam is pierced by the drill will be indicated by an increase in the rate of discharge through the meter placed on the supply line.

Both steam and air pressure were used for grouting at a pressure limited to 40 lb. per square inch. At this pressure scarcely two pails of grout per hole could on the average be forced into the seams. A 1:1 mixture was tried but it did not work so well as the neat cement grout. It was sluggish and too slow in responding to such pressures as we thought it safe to apply. In fact a very thin mixture had to be used before we could get the grout to appear at adjacent holes at all. I do not know the ratio of the water to the cement, but it must have been at least 5 to 1. We had no special equipment in the way of grout machines or tanks, but had facilities for quickly connecting the air or steam line to the holes and for easily controlling the pressure applied. The usual procedure was to fill the hole with grout, apply the pressure and leave it on for 15 or 20 minutes, or until the escape of air or steam at some other hole showed that the grout had been forced down below the level of a seam when the pressure line would be disconnected and the operation repeated.

Test to Determine Uplift Pressure.—In addition to the row of grout holes along the heel of the dam, a number of test holes were provided both upstream and downstream for the grout holes. The downstream row was piped through the sill of the dam. These test holes were used in making the experiments already described, but served their real purpose in connection with the final and most important test of all, viz., the test to predetermine what the uplift pressure would be in the seams immediately below the dam under future conditions. Obviously this test was simply a matter of supplying water to the upstream holes and maintaining it there under a head equivalent to the future forebay level, and at the same time noting the pressure in the holes under the dam. The fact that the water did not overflow the holes piped through the sill of the dam was proof that whatever leakage there might be past the grout holes did not at all over tax the capacity of the seams to discharge it to the tailrace or to the natural channel below the dam.

Grouting gave good results at Pont Rouge, and at much less cost than even a 5 ft. deep cut-off. Moreover, dispensing with the trench expedited the work considerably, as the contractor could start pouring the sill as soon as the debris and loose rock were removed from the site.

Filter Plant Operation at St. Louis

The following notes on the operation of the Chain of Rocks Filters of St. Louis, Mo., for the year ending April 1 last, are taken from the annual report of Edward E. Wall, Water Commissioner:

During the year 40,900 million gallons of water were filtered, an average of 112.3 million gallons per day at a cost of $4.01 per million gallons. The cost includes the operation, maintenance, repairs, light, power, coal and the chemicals used in the applied and filtered water.

During the year each filter was washed on an average of 154.4 times, making a total of 6,177 washes, using 576.41 million gallons of water, amounting to 1.409 per cent of the water filtered. The rate of filtration has varied during the year from a maximum of 117.6 million gallons per day to a minimum of 67.4, the average for the year being 87.50 million gallons per acre per day. The maximum run of a filter was 169.08 hours, filtering 21.50 million gallons; the minimum was 12.50 hours, filtering 1.48 million gallons; the average being 57.90 hours, and filtering 6.69 million gallons.

The 40 filters were continually in service, except for short periods when minor repairs were being made. The rate of washing filters has not been changed throughout the past year, and is at the rate of 15 gallons per square ft. per minute. By washing at this rate there has been no noticeable change in the size and number of mud balls. Once each month a ¼-inch screen is pulled through one section of each half of filter when washed, then mud balls are counted, and in this way a good check is kept on conditions of sand bed.

Water Wastes, Meters and Rates at Baltimore

A Comprehensive Study and Analysis Based on Surveys Covering Present Conditions, Anticipated Results, Financing Problems and Installation Details in a Review Presented to the Engineers' Club of Baltimore, March 28, 1923

By V. BERNARD SIEMS, C. E.,
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Published Serially in Engineering and Contracting

Part II—Meters, Rates, Comparisons and Costs

Meters may be divided into two types, positive displacement meters, in which the volume of water is actually measured, and inferential meters, in which the volume of water is inferred from the velocity of the current. The various disc meters represent the first type. The meter usually consists of the main casting or housing, having inlet and outlet spuds, an inner chamber containing the measuring chamber, the gear train, and the register.

Current meters typify the class of inferential meters. The volume of water flowing through this type is measured by its velocity, the water flowing through a chamber wherein is located a propeller, the latter revolving in proportion to the pitch of blades and the velocity of the water. The meter thus indicates velocity, the revolutions of the propeller being transmitted to the dial by suitable mechanism and the quantity of water passing through the propeller chamber thereby recorded. All types of velocity meters are variations of this principle, in some types, however, the propeller being replaced by a turbine shaped piston.

Another class of meter is the proportional meter, whereby a large volume of water flowing at a relatively high velocity is measured by a disc meter placed on a bypass. Within certain limits the flow of water through the bypass will be a fixed percentage of that through the main, and by a suitable arrangement of gears the register of the meter indicates the total quantity of water.

Combinations of large and small meters are also manufactured to provide an efficient unit to measure normal small flows and also unusually large drafts. These compound meters are merely combinations of current meters and positive displacement meters, the former for measuring large flows, the latter to indicate the small draws, the displacement meter of the disc type, being placed on a bypass with a controlling valve in the main line so constructed as to remain closed normally, and to open automatically only for large flows. That is, the disc meter always records but when the volume being drawn is too great the larger current meter becomes operative through the opening of the bypass valve. The efficiency of a compound meter depends entirely upon this controlling valve, for if the valve does not respond quickly and much water is drawn at a rate varying about this transitional point, the meter will not register correctly.

Costs of Meter Installation.—The various sizes and combinations of the different types of meters provide accurate and flexible instruments to efficiently record most any type of water consumption. From data available in the Engineering and Construction Division of the Water Department it is computed that a foreman and four men can install four ⅝-in. meters per day (outside vault installation) in isolated locations at a cost of $23.00 per meter, comprising the following items:

	1 ⅝-in. meter		$9.45
Meter	2 Valves	$1.46	
Connections:	2 ¾-in. Ells	.15	
	7 ft. ¾-in. Wrought Iron Pipe	.58	
		$2.19, say	2.20
Meter Vault:	Frame and Cover	$2.50	
	Armco or Terra Cotta Pipe	2.50	5.00
	Total Materials		$16.65
Labor Cost		$ 4.00	
Depreciation on tools 5 per cent of labor		.20	
		$20.85	
Overhead 10 per cent		2.08	
		$22.93	
		say,	$23.00

Whereas in locations where there are a number of meters to be placed in the same vicinity (100 per cent metering system), a water pipe construction foreman with from four to six laborers can install from seven to ten meters (outside vault installation) per day, the cost per meter installation being as follows:

Materials	$16.60	
Labor Cost	3.00	
Depreciation on tools 5 per cent of labor	.15	
	$19.80	
Overhead 10 per cent	1.98	
	$21.78	
say,		$22.00

In the writer's "Investigation of the Water Supply Improvements for Greater Baltimore (December, 1919), it was estimated that seventy per cent of the ⅝-in., ¾-in., 1½-in. and 2-in. meters could be installed inside of the building and thirty per cent in the sidewalk near the curb. Reference is here made to prevailing conditions in most old sections of Baltimore where the building wall of the houses coincide with the building line of the public highway.

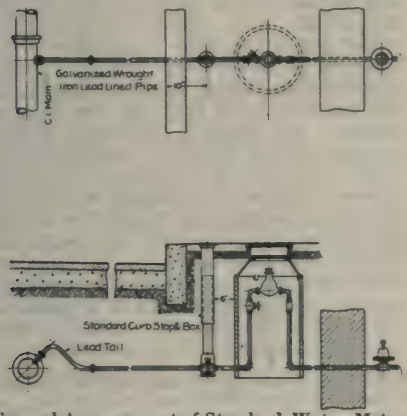
The estimated cost for installing a ⅝-in. meter inside of the building wall is as follows:

	1 ⅝-in. meter		$9.45
Meter Connections:	2 Valves	$1.46	
	2 ¾-in. Ells	.15	
	4 ft. ¾-in. Pipe	.33	
		$1.94, say	1.95
			$11.40
Labor			$ 1.75
Depreciation on tools 5 per cent of labor			.09
			$13.24
Overhead 10 per cent			1.32
			$14.56
say,			$15.00

Cost of Meter Installations (January, 1922) 100 Per Cent Metered System.—The following gives the total cost of installation on a 100 per cent metered system, the number and size of water supply service connections in January, 1922, as given in "Recommended Schedule of Rates for the Water Department of the City of Baltimore" being used as a basis:

⅝-in. meter at a total cost of $15.00 (inside, 70 per cent) and $22.00 (outside 30 per cent)—total cost of installation, respectively.					
134,292—⅝-in. @ $9.45 per meter plus labor, etc.—					
(Inside)	94,004.4	@ $15.00 =	$1,410,066.00		
(Outside)	40,287.6	@ 22.00 =	886,327.20		
				$2,296,393.20	
227—¾-in. @ $14.18 per meter plus labor, etc.—					
(Inside)	193.9	@ $20.00 =	$3,876.00		
(Outside)	83.1	@ 30.00 =	2,493.00		
	277.0			6,871.00	
706—1-in. @ $20.79 per meter plus labor, etc.—					
(Inside)	492.2	@ $25.00 =	$12,355.00		
(Outside)	211.8	@ 35.00 =	7,413.00		
	706.0			19,768.00	
1,523—1½-in. @ $38.00 per meter plus labor, etc.—					
(Inside)	1,066.1	@ $45.00 =	$47.974.50		
(Outside)	456.8	@ 60.00 =	27,414.00		
	1,523.0			75,388.50	
2-in. meter @ $57.00 per meter plus labor, etc.—					
(Inside)		@ $65.00			
(Outside)		@ 80.00			
				$2,397,920.70	
				say,	$2,400,000.00
Complete Cost of Installation of Private Fire Protection Supplies:—					
119— 3-in. meters—	$ 91.80	plus labor, etc.	$ 185.00	$ 22,015.00	
223— 4-in. meters—	158.00	plus labor, etc.	275.00	61,325.00	
351— 6-in. meters—	306.00	plus labor, etc.	465.00	163,215.00	
35— 8-in. meters—	702.00	plus labor, etc.	920.00	32,200.00	
14—10-in. meters—	936.00	plus labor, etc.	1,200.00	16,800.00	
2—12-in. meters—	1,425.00	plus labor, etc.	1,800.00	3,600.00	
				$299,155.00	
				say,	300,000.00
Total					$2,700,000.00

Meter Repairing.—The present meter repair shop occupies a corner of the Water Department machine shop, being merely a space about fifteen feet wide and twice as long. The equipment here is rather simple, consisting of a meter testing bench with tank and scale for meters varying from ⅝ in. to 2 in. in size, a testing bench for 3 in. and 4 in. meters and



General Arrangement of Standard Water Meter Setting—City of Baltimore, Water Department.

the necessary work tables and cabinets.

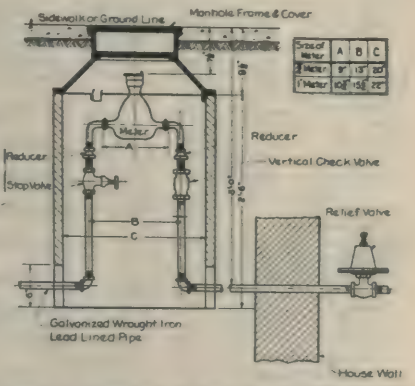
Small meters, tested and ready for installation, are stored in a balcony over the shop, larger sizes being placed on the floor in portions of the adjoining shop. On account of lack of space large meters are kept in an open shed in the yard. Meter parts required in repair work are under the jurisdiction of the Water Department Storekeeper, and located in another building because of insufficient room. Due to this arrangement time is lost in securing material.

Despite the simplicity and inadequacy of the present arrangements, all of the meters now used in the city, varying from ⅝ in. to 6 in. in size, are here repaired and tested. In connection with the extension of metered water supply services, however, whether on a partially or universally metered basis, it will be necessary to reorganize and enlarge the present equipment.

Features of an Efficient Meter Shop.—It would perhaps be more advantageous to design and erect a building arranged primarily for the efficient testing and handling of meters rather than to modify an ideal arrangement so as to conform to the limited space now available. The design of this building should be such as to permit a logical progression of events to occur in the simplest and quickest order.

To begin with, there should be a receiving platform with a chain fall on overhead tracks, these tracks to run throughout the shop over the course to be taken by the meter from its arrival to its final shipment to the consumer. At this platform should be stationed a stock clerk, who, after making a record of all the details required for identification, forwards the meter to the space equipped for cleaning, scraping and, if necessary, painting. Here should be located the acid tanks for the cleaning of bronze parts, and benches where the meter may be taken apart and cleaned.

Further on should be located repair benches capable of holding several meters. Still further on should be placed the testing benches, then equipment for painting, and finally an adequate storage space for all sized meters. In conjunction with this, of course, it will be necessary that a completely equipped office be established. It is also desirable that a stock room be located immediately ad-



Detail of Standard Water Meter Setting—City of Baltimore, Water Department.

joining the repair benches. Miscellaneous equipment, such as a lathe, drill press and emery wheel should also be included.

In the basement should be located a 10,000 gallon capacity tank on a platform scale—the beam being on the upper floor—and storage space for small meters and bins for salable scrap, such as bronze and hard rubber.

For a distribution system compris-

ing 50,000 meters, two repair men would be sufficient, an additional workman to be added for each increment of 50,000 meters, that is, the force should be doubled when a total of 150,000 meters are in service. For 100,000 meters there should be a single and a multiple meter testing bench, the latter to be used for new meters only. For 150,000 meters an additional single testing bench should be secured. Each bench is to have its individual scale and tank, the benches to be for meters from ⅝ in. to 2 in. in size, as these sizes are greatly in the majority. There should, however, be facilities for testing meters from 3 in. to 6 in. in size and also a testing bench for meters 8 in. to 12 in.

Plans have already been completed for the erection of a modern meter testing shop on space now available in the Gay Street Yards. This proposed building will not only overcome the deficiencies of the present equipment but will also embody the salient features of the meter testing equipment of the most progressive private water companies.

Cost of Repairing and Testing Meters.—The total estimated cost of repairing meters is approximately $45,000.00 for the 155,006 services ($7,334.00 for the present 17,464 metered water supply services ranging in size from ⅝ in. to 6 in., and $38,547.20 for 137,542 unmetered water supply services ranging in sizes from ⅝ in. to 12 in.). We have found it more economical on small meters to replace and send them to the testing station for repairs, although minor repairs on all sizes are usually made with the meter in position. With the present system of making connection from service pipe to meter the meter can be readily removed and replaced. This is true only of ⅝ in., ¾ in., 1 in. and 1½ in. meters. On compound meters of a special type it is possible to remove one unit for repair, regis-

Table IX—Table of Consumption of Water by Meters of Consumers Using 2,250,000 Gallons (300,000 Cu. Ft.) or Over for Year (Year 1919)

	No. of Consumers	No. of Water Service Supplies	Total Yearly Consumption in Gal.	Av. Yearly Consumption for Each Consumer in Gal.	Average Daily Consumption (300 Days) in Gal.	Av. Daily Consumption for Each Consumer in Gal.	Av. Daily Consumption Through Each Water Supply Service in Gal.
Low service:							
Industrial Plants	147	198	2,766,897,000	18,822,000	9,222,990	62,740	46,581
Manufacturing of Food Products	56	70	806,532,000	14,402,000	2,688,440	48,000	38,406
Sales of Commodities Stores	19	22	316,869,000	16,677,000	1,056,230	55,590	48,010
Apartment Hotels, Hotels	59	77	828,952,000	14,050,000	2,763,180	46,830	35,885
	281	367	4,719,250,000		15,730,840		
Middle service:							
Industrial Plants	27	29	431,170,000	16,000,000	1,437,230	53,330	49,560
Manufacturing of Food Products	18	29	429,556,000	23,864,000	1,431,850	79,550	49,374
Apartment Hotels, Hotels	24	46	319,506,000	13,313,000	1,065,020	44,370	23,154
	69	104	1,180,232,000		3,934,100		
High service:							
Industrial Plants	1	1	8,017,000	8,017,000	26,720	26,720	26,720
Apartment Hotels, Hotels	2	2	5,505,000	2,753,000	18,350	9,180	9,180
	3	3	13,522,000		45,070		

Total average daily water consumption through 4,187 meters year 1919 ..... 21,897,309 gallons
Total average daily water consumption through 474 meters year 1919 } For consumers using 2,250,000 gal. (300,000 cu. ft.) per year or over } cut ..... 19,710,010 gallons
Total average daily water consumption through 3,713 meters year 1919 } For consumers using less than 2,250,000 gal. per year } cut ..... 2,187,299 gallons
Average number of gallons per day passing through meters of consumers using 2,250,000 gal. (300,000 cu. ft.) or over for year ..... 43,780 gallons
Average number of gallons per day passing through meters of consumers using less than 2,250,000 gal. per year ..... 590 gallons
Average number of gallons per day passing through meters of industrial plants using 2,250,000 gal. or over per year ..... 61,068 gallons
Total number of water supply services year ending Dec. 30, 1919 ..... 140,000 (approx.)

3 Per Cent of Water Supply Services Metered.

tration being continued by the second meter. In some instances duplicate installations are made on the water supply service pipe so as to give uninterrupted service in the case of necessary repairs.

The following gives the present cost of, and the forces employed in, repairing meters and assisting in the reading and installing of new meters on application:

Field work:	
Junior Civil Engineer in charge of testing meters	$ 1,600.00
2 Water Meter Repairmen at 72c hr. (8-hr. day)	3,456.00
2 Laborers at 40c hr. (8-hr. day)	1,920.00
2 Auto Trucks (1-ton capacity) 76c hr. (8-hr. day)	3,600.00
Testing station:	
1 Meter Repairman at 72c hr. (8-hr. day)	1,728.00
2 Laborers at 40c hr. (8-hr. day)	1,920.00
Total labor for meters in sizes ⅝ in. to 6 in.	$14,224.00
Cost of material for repairing 1,500 meters of the 17,464 total at present	4,500.00
Total present repair cost per year	$18,724.00

The present labor and material cost per meter per year is $1.072 ($0.814 for labor and $0.258 for material). The labor cost is excessive as these same forces can take care of three times the present number of meters or about 50,000 meters at the same cost, e. g., one Junior Civil Engineer in Charge of Testing Meters can care for 155,000 meters. The Old City districts, New Annex and counties require an organization at the costs given. It would be more economical, therefore, to enlarge the number of meters, as at the present time, January 1, 1923, they aggregate approximately 22,000, the same forces taking care of them.

The average cost of repairs per year for a ⅝ in. meter in service twenty years (original cost $7.50 to $7.90) has been from $0.18 to $0.32; or $0.03 to $0.04 per 1000 cubic feet of water registered; on a ¾ in. meter (original cost $11.25 to $14.25) in service twenty years, from $0.26 to $0.67, or $0.0052 to $0.0195 per 1000 cubic feet of water registered; and on

Table X—Maintenance of Meters and Supplies of Various Sizes (Based on Useful Life of 20 Years)

Number of Water Supply Services January, 1922 (1)	Metered Water Supply Services Size of Pipe (2)	Size of Meter (2)	Yearly Unit Maintenance Charge for Water Supply Service Pipe (3)	Aver. Yearly Unit Cost of Labor and Material for Meter Repairs (4)	Cost of Meter (5)	Depreciation Per Year Determined Straight Line Method (6)	Total Yearly Maintenance Charge for Water Supply Service Pipes (7) 7 = 1x3	Total Average Yearly Cost of Labor and Material for Repairing Meters (8) 8 = 1x4
				UNMETERED				
Discs:								
134,292	¾ in.	⅝ in.	$1.25	$ .25	$ 9.45	$ .47	$167,865.00	$33,573.00
277	1 in.	¾ in.	1.40	.35	14.18	.71	387.80	96.95
706	1½ in.	1 in.	1.55	.50	20.79	1.04	1,094.30	353.00
1,523	2 in.	1½ in.	1.70	.90	38.00	1.90	2,589.10	1,370.70
0	3 in.	2 in.	1.95	1.35	57.00	2.85	.....	.....
Comp. or Similar:								
119	4 in.	3 in.	2.25	2.15	91.80	4.59	267.75	255.85
223	6 in.	4 in.	2.60	3.65	153.00	7.65	579.80	813.95
351	8 in.	6 in.	3.05	7.50	306.00	15.30	1,070.55	2,632.50
35	10 in.	8 in.	3.60	17.00	702.00	35.10	126.00	595.00
14	12 in.	10 in.	4.25	22.50	936.00	46.00	59.50	315.00
2	14 in.	12 in.	5.00	32.50	1,425.00	70.70	10.00	65.00
137,542	Total						$174,049.80	$40,070.95
				METERED				
Discs:								
12,365	¾ in.	⅝ in.	$1.25	$ .25	$ 9.45	$ .47	$ 15,456.25	$ 3,091.25
2,460	1 in.	¾ in.	1.40	.35	14.18	.71	3,444.00	861.00
982	1½ in.	1 in.	1.55	.50	20.79	1.04	1,522.10	481.00
440	2 in.	1½ in.	1.70	.90	38.00	1.90	748.00	396.00
Comp. or Similar:								
547	3 in.	2 in.	1.95	1.35	57.00	2.85	1,066.65	738.45
396	4 in.	3 in.	2.25	2.15	91.80	4.59	891.00	851.00
202	6 in.	4 in.	2.60	3.65	153.00	7.65	525.20	737.30
72	8 in.	6 in.	3.05	7.50	306.00	15.30	219.60	540.00
17,464							$ 23,872.80	$ 7,706.40
155,006	Grand Total						$197,921.60	$47,777.35
							Say $198,000.00	$52,650.00

Columns 3, 4, 7 and 8 are embodied in the consumers' charge, which is 25 per cent of the fixed service charge. The fixed service charge equals the capacity or readiness to serve charge (75 per cent) plus consumers' charge (25 per cent), or 40 per cent of the general water service revenue.

a 1 in. meter (original cost $15.00 to $19.80) twenty years in service $0.26 to $0.41, or an average of $0.0073 to $0.011 per 1000 cubic feet registered.

Table No. 10 shows the cost of labor and materials for repairing, based on life of twenty years.

The total cost of labor and material for the average yearly repairing of meters is $52,650.00 or $0.34 per year per meter. According to statistics collected on various makes of meters and covering a period of twenty years, approximately ten per cent, or 15,000 meters, per year of the total of 155,-006 metered services (100 per cent metering) will require repairs at an average cost of $3.50 per meter or $52,500.00, which almost equals the total estimated for repairs. An important consideration in this estimate is that only about four standard makes of meters will be used (in private water companies one standard make is used, which is preferable), these four types to be zoned, one certain section of the City using one specified type of meter. By this means the district meter repair men will become experts on one type, thereby increasing their efficiency. Another advantage will be a decrease in the multiplicity of repair parts, and a marked decrease in operating cost and repair cost will be experienced if this is made an established practice.

The following organization is necessary for repairing meters by the Engineering and Construction Division of the Water Department with a completely metered system:

Shop meter testing station:	
Junior Civil Engineer—meters	$ 1,800,00
1 Water Meter Repairman at 72c hr. (8-hr. day)	1,728.00
1 Water Meter Tester (Engineering Aid)	1,300.00
2 Water Meter Repairmen at 64c hr. (8-hr. day)	3,072.00
3 Water Meter Repairmenhelpers at 40c hr. (8-hr. day)	2,880.00
Field work:	
2 Water Meter Repairmen at 72c hr. (8-hr. day)	3,456.00
3 Water Meter Repairmen at 64c hr. (8-hr. day)	4,608.00
5 Water Meter Repairmen helpers at 40c hr. (8-hr. day)	4,800.00
5 Auto Trucks at 75c hr. (8-hr. day)	9,000.00
Total cost of labor for repairing meters (155,000)	$32,644.00
Say	$32,650.00

The City of Detroit has sixteen water meter repairmen receiving $0.55 per hour, whereas in the City of Baltimore eight meter repairmen at $0.64 to $0.72 per hour will be used. Meter repairmen should be men specially trained in the work, our present men being occasionally sent to meter plants for instruction.

An assumption of 15,000 meters to repair per year, or 50 per day on a basis of 300 working days, requires that on an average each field water meter repairman has to remove and replace 10 meters per day and make minor repairs, and that each shop water meter repairman repair 16 or 17 meters per day. This is good efficiency and is paralleled by our present system. Meters should be tested every two years if possible; this makes an added cost with the present organization, but is necessary to give the maximum registration and revenue.

History of Certain Old Meters.—In 1902, twenty years ago, the first ⅝ in. disc meter of a certain type was installed. Records of the first five installations show that these meters cost $7.50 each, or $37.50 for the group. In their twenty years of service those meters have registered almost a half million cubic feet of water and have cost $17.95 for repairs, or an average repair cost of less than $0.18 per meter per year, and an average cost of repairs per thousand cubic feet registered of approximately $0.035. A ¾ in. meter installed in May, 1901, almost twenty-two years ago, has registered 92,000 cubic feet and has cost but $2.60, or less than $0.12 per year for repairs, while another ¾ in. meter installed in October, 1898, over twenty-four years ago, has registered 73,000 cubic feet and has cost but $3.55, or less than $0.15 per year for repairs. A ⅝ in. disc meter, similar to the type which we propose to install, installed in April, 1899, almost twenty-four years ago, has registered 226,000 cubic feet and has cost but $6.30, or $0.26 per year in repairs, or less than $0.03 per thousand cubic feet registered.

These figures conclusively show that the repair costs of meters is not high and we have, moreover, not given figures for large sized meters, where the repair costs are always lower, but have purposely limited the examples to the small meters of the type which will be installed in the average residence.

Meter Reading.—During the past year the Meter Account Subdivision (for Old City) employed four readers, the bills being rendered quarterly,

readings being made in March, June, September, and December. As these four men read but 4,000 meters quarterly, or 1,000 meters per man per year, at first glance it would appear that any increase in the number of meters would proportionately increase the number of meter readers. This, however, is entirely wrong, as several factors enter into the problem. The present routes for a meter reader vary from six to thirty-three miles in extent; some of the assignments being composed of a comparatively few locations very widely scattered, causing much loss in time and naturally increasing the cost of each read. If universal, or practically universal, metering is adopted the Department's problem of reading is immediately placed on a par with that of the Gas Company. The meters would be immediately adjoining, as every property would be metered, and instead of reading one meter in this block, two meters, say, in the next block and then proceeding some six or seven blocks away to read the fourth one, and continuing this procedure all day long, it would merely be a matter of going from door to door.

The present read lasts about two weeks each quarter, i. e., each man reads about 500 meters a week. The remainder of the time between the quarterly readings is spent on inspecting services and miscellaneous kindred duties. If, however, this associate work were transferred to men employed thereon continually, say two or three additional men, the meter readers could be continually assigned to the actual work of reading. If this were done the reader would in the course of a year—based upon an average of 150 meters a day—make 45,000 readings a year, or sixteen men could care for the entire system. To permit of such an arrangement under the present system, it has been decided to divide the entire city into sections. A new series of quarters would then begin, perhaps every two weeks. For instance, in a certain portion of the city the quarters would be March 1st, June 1st, September 1st, and December 1st, the second series March 15th, June 15th, September 15th and December 15th, the third would be April 1st, July 1st, October 1st and January 1st, and larger intervals between the quarters, but the principle thereof is seen, i. e., to permit continuous reading.

The present cost of reading 17,464 meters (January, 1922) varying in size from ⅝ in. to 12 in. is $0.66 per meter per year, or $0.165 per meter per read. This includes 12,899 meters from ⅝ in. to 6 in. belonging to the former private water companies, and 4,565 meters ⅝ in. to 12 in. on the City's distribution system:

4 Water Meter Readers at $1,200 per annum	$ 4,800.00
4 Water Meter Readers Helpers at 37½c hr. (8-hr. day)	3,600.00
2 Autos at 65c per hr. (8-hr. day)	3,120.00
Total	$11,520.00

Two of these Water Meter Readers assist in the recording and computing of the City meter accounts. The cost of reading water meters only is excessive in that the water meter readers assist in the computing of charges, make inspections and must travel long distances from meter to meter when on the quarterly read. The cost of reading meters on a one hundred per cent metered system will be very much less and will be somewhat comparable with the district in the former private water companies' territories.

On a cloudy day in the Towson district (system 100 per cent metered) of the former Baltimore County Water & Electric Company, 330 meters were read at a cost of $17.58 per day, or a cost per reading of $0.0533, or $0.2132 per year per meter. In the Govans district on a clear day 690 meters were read at a cost per day of $17.58, or a cost per reading of $0.0255, or $0.1020 per year per meter. These meter readers do not assist in the computing of charges for the billing of consumers.

It is possible to say that, for a conservative estimate, the cost of reading meters on a one hundred per cent, metered distribution system will be $0.0455 per meter read, or $0.1935 per meter per year for 155,006 metered water supply services. Meters will be read according to size, that is, ⅝ in., ¾ in., 1 in. and 1½ in. meters will be read in quarterly periods; 2 in., 3 in. and 4 in. meters will be read monthly; and 6 in., 8 in., 10 in. and 12 in. meters, weekly. There were (January, 1922) 136,798 supplies to be metered and 16,247 metered supplies, or 153,045 meters to be read in quarterly periods (four times a year or 612,180 meter readings); 342 unmetered supplies to be metered and 1,145 metered supplies, or 1,487 meters to be read in monthly periods (12

times a year or 17,844 readings); and 402 unmetered supplies to be metered and 72 metered supplies, or 474 meters to be read in weekly periods (52 times a year or 24,648 readings). The estimated grand total number of meters to be read in one year (1922, January) is 654,672, or in round numbers 660,000 to be read in 300 working days.

There were (January, 1922) 134,292 ⅝ in., 277 ¾ in., 706 1 in., 1,523 1½ in., 119 3 in., 223 4 in., 351 6 in., 35 8 in., 14 10 in. and 2 12 in. unmetered fire protection supplies; the sizes of the metered supplies being: 12,365 ⅝ in., 2,460 ¾ in., 982 1 in., 440 1½ in., 547 2 in., 396 3 in., 202 4 in. and 72 6 in., respectively, or a total of 155,006 supplies (137,542 unmetered and 17,464 metered).

A conservative assumption of 150 meters to be read per day per reader will require sixteen meter readers. This corresponds to conditions in Detroit, Mich., where the water system is one hundred per cent metered.

The cost of meter reading is as follows:

16 Water Meter Readers at $1,200 per annum	$19,200.00
6 Water Meter Reader Helpers at 35c per hr. (8-hr. day)	5,040.00
3 Autos at 65c per hr. (8-hr. day)	4,680.00
Total	$28,920.00

Say, $30,000.00 or $\frac{\$30,000.00}{660,000} = \$0.0455$ per meter per read, or

$\frac{\$30,000}{155,066} = \$0.1935$ per meter per year.

There will be no office work for meter readers as this is to be handled independently (see cost of billing and collecting).

The above figures show that with a one hundred per cent metered distribution system the cost per meter per read will be considerably less in that more meters will be read in a day and the distance between meters will be from 12 to 100 feet. The difficulties encountered in reading a water meter are very much greater than those of reading a gas meter, as outside vaults often become filled with surface water or other debris. In the suburban districts it will be necessary to place the water meter on the sidewalk for, as a rule, the dwelling houses are set back a considerable distance from the building line of the highway. The cost of reading meters in such instances will probably be a little greater than the cost of reading in the congested residential section where the meters are inside of the building wall.

Should a good type of meter manhole construction be used—the estimated cost is based on such construction—and the vault tops be nearly water tight to prevent the entrance of surface water, and of a nature to prevent freezing; the cost of reading will approximate to that of reading meters inside of dwellings. The estimated cost for the reading of meters, exclusive of accounts, collections, etc., on a one hundred per cent metered system (155,006 water supply services January, 1922), that is, reading 660,000 in 300 days, will be $30,000.00 per annum, or $0.0455 per meter per read and $0.1935 per meter per year. The present cost of house to house inspections is $15,000.00 per annum which will be discontinued upon the installation of a completely metered system, and, therefore there is only an additional cost of $15,000.00 to be charged against reading meters.

Billing and Collecting.—The following gives the present cost of billing and collecting for 155,006 metered and flat rate services—17,464 metered accounts and 137,542 flat rate accounts:

Office of collector of water rents and licenses:		
Salaries	$46,600.00	
Expenses	9,000.00	
Total		$55,600.00
Engineering and construction division—water department:		
Salaries—		
Principal Meter Clerk	$ 1,800.00	
1 Clerk	1,100.00	
2 Clerks (Water Meter Readers)	2,400.00	
1 Typist	1,000.00	
	$ 6,300.00	
Expenses	100.00	
		6,400.00
Total		$62,000.00

or a total cost for both the offices of the Collector of Water Rents and Licenses and the Engineering and Construction Division, Water Department for metered and flat rate accounts of $62,000.00. The present cost of accounting, billing and collecting is $0.402 per service per year.

By using modern billing machines and other work-saving office equipment, the following employees will be required on a 100 per cent metered system:

Water Rent Collector (under Dept. of Finance City Charter)	$ 3,500.00
Principal Meter Clerk (E. & C. Div., Water Dept.)	2,500.00
6 Ledger Clerks, handling 2,400 accounts per day, or 400 accounts per day each, and 55 per hour, at $1,500.00 each (E. & C. Div., Water Dept.)	9,000.00
4 Billing Machine Operators (Typist)	

2,400 bills per day, or 600 each, or 90 per hour, at $1,200.00 each (E. & C. Div., Water Dept.)	4,800.00
2 Addressograph Operators (Typist) 2,400 per day, or 1,200 each, or 180 per hour, at $1,000.000 each (E. & C. Div., Water Dept.)	2,000.00
3 Stencil Operators (stamp bills and check computed accounts) 800 per day, or 115 per hour, at $1,300.00 each (E. & C. Div., Water Dept.)	3,900.00
4 Cashiers (alternate on balancing and receiving cash) 600 accounts per day, or 85 per hour, at $1,500.00 each (Dept. of Finance)	6,000.00
4 Filing and Indexing Clerks and determining inoperative meters, 600 per day each, or 85 per hour, at $1,300.00 each (E. & C. Div., Water Dept.)	5,200.00
3 Bookkeepers, post up daily collections and review accounts and delinquent accounts, 800 per day, or 115 per hour, at $1,800.00 each (Dept. of Finance)	5,400.00
2 Application Clerks (also to be employed to direct consumers about complaints), at $1,300.00 each (E. & C. Div., Water Dept. or Dept. of Finance)	2,600.00
Total	$44,900.00
Present accounting and comemrcial expense ($19,650.00) of Auditing Division, Water Dept., not considered, as this amount remains constant.	
Say,	$45,000.00
Expenses—stationery, printing, delivering of bills, etc.	17,000.00
Total	$62,000.00

It is proposed that all of the billing, preparation of accounts, etc., be taken care of by the Principal Meter Clerk, Engineering and Construction Division, Water Department; and that collection only be handled by the Department of Finance. The above mentioned figures are comparable with those of Detroit, Mich., where the water distribution system is 98.5 per cent metered, with 156,632 revenue producing water supply services.

The proposed cost of accounting, billing and collecting for a completely metered system is $0.094 per meter per read or $0.40 per meter per year, which is practically the same as for the present metered and flat rate system. Progressive meter reading will —although the bills are rendered in quarterly periods—allow the office forces to perform a uniform amount of work each day, and it will therefore require the same appropriation as is now necessary.

Metering Private Fire Systems.—For the past two years the Department has followed the policy of metering all private fire protection supplies. Although there has been intermittent opposition to this practice, the justice and advisability of the theory is becoming more acceptable to all concerned. All plants of sufficient size to require a private fire protection supply are usually large enough to consume much water, which is distributed through a rather intricate system of piping. A source of water which is not paid for and not depleted by any previous drafts—as is often the case with the domestic supply—appears to be a constant inducement for illegal or unauthorized use. For instance, the outlets designed to serve as hose connections in case of fire are more often used as a source of water for washing driveways or yards. One large local corporation illustrates this point, the

Table XI—Comparison of Present Cost of Metered and Unmetered System With Estimated Costs for 100 Per Cent Metered System

PRESENT COSTS		ESTIMATED COSTS	
Present cost of reading 17,464 meters $0.660 per meter per year $0.165 per meter per read	$11,520.00	Estimated cost of reading 155,006 meters $0.1935 per meter per year $0.0455 per meter per read	$30,000.00
Cost of present house to house inspection for eliminating leaking fixtures	15,000.00		
Present accounting and collecting costs for 17,464 metered supplies and 136,798 flat rate accounts—$0.402 per service per year	62,000.00	Estimated cost of accounting and collesting for 155,000 metered supplies $0.40 per meter per year $0.094 per meter per year	62,000.00
Present cost of repairing meters, including labor and materials—17,464 metered supplies—$1.072 per meter per year	18,724.00	Estimated cost of repairing 155,006 meters, including labor and material $0.34 per meter per year	52,650.00
Total	$107,244.00	Total	$144,650.00

Added necessary expense to maintain a 100 per cent metered system against the present (11 per cent +) metered and (89 per cent —) flat rate system is $144,650.00 less $107,244.00, which equals $37,406.00, or approximately $37,500.00.

sidewalks and streets adjoining its property being washed every Saturday afternoon with water taken from the fire supply. When one considers that the water is allowed to flow some two or three hours and the property covers several city blocks, the quantity of water so wasted is appreciated. Sometimes it is a far simpler matter to tap the fire line and run a connection therefrom, instead of extending a line from the authorized supply. Convincing arguments are also offered to explain why so many interconnections exist between the domestic and the fire supplies. One or more such connections are necessary, legal and justified, but they also offer a constant inducement to reduce the meter bill by leaving open a valve or two.

If, however, all water entering the property is measured the Department has no interest in the interior connections, the only further interested outside agencies being the Plumbing Inspector and the Health Department, the latter in order to discourage any connection between the City distribution system and any piping conveying water from wells and sumps which may be polluted.

Efficiency of a 100 Per Cent Metered System.—When we consider the operation of a water works utility to obtain the efficiency thereof, we must compare the records of a master measuring device with the summation of the records of all the smaller units, the master meters being located at the impounding works, filtration plant, and the various pumping stations, the smaller units being on the individual water supply service pipes. By comparing a certain portion of the water distribution system which is secured from Venturi Meters placed on the large feeder water mains with the gross registration of all of the metered services, the ratio of water entering the section and of water legitimately used is determined. In other words, the efficiency of that particular section is quickly arrived at.

On a completely measured water distribution system twenty per cent of the water is usually unaccounted for, that is, the system is eighty per cent efficient. This unaccounted for water includes the consumption of municipal buildings, the Fire Department, Street Cleaning Department and water used in the paving of streets, the installation of sanitary sewers and storm water drains, and miscellaneous uses, such as fountains and horse troughs. With the exception of water secured from fire hydrants for several purposes, all of these demands could be measured by the installation of meters so that the only water unaccounted for would be actual leakage, and the Department would be constantly aware of the amount of underground waste to be eliminated.

At the present time the water distribution system of the City of Baltimore is approximately 900 miles in extent, which in conjunction with the 100 miles of water main formerly belonging to the several private water companies, gives a total extent of 1000 miles. As previously mentioned the records of the pitometer survey indicate that sixty per cent of the leakage found is outside of the curb stops and on the distribution system proper. The remaining forty per cent would be removed by the installation of meters so that the percentage of unaccounted for water would be directly dependent upon the rapidity of the pitometer work and its decrease would constantly allow the efficiency of the system to approach one hundred per cent. Our present records, based upon a survey of over one-tenth of the entire mileage of distribution system indicate that four per cent of the total water filtered each day is lost through underground leakage.

Flat Rate Injustices.—It has been repeatedly stated and admitted by householders of all classes that the present front footage water service rates are unjust in that there is absolutely no relationship between the width of the dwelling and the amount of water consumed. There are now in certain of the older portions of the city many large houses occupied by only one family; these houses despite the small number of occupants are, because of their wide front footage, assessed as great consumers of water and a comparatively high water bill is rendered. Upon the other hand, every day more and more of the usual three-story or sixteen-foot front houses are being converted or adapted for use as flats or apartments for two or three families. Despite the large number of occupants in this type of house the water rent, because it is fixed upon the front footage, remains unchanged, so that we have the paradox of a household of three or four

individuals paying $11.50 because their property has a footage of seventeen feet, while the fifteen-foot house, occupied by several families, continues to pay $7.50.

Innumerable examples of such apparent discriminations can be cited but everyone is familiar with this condition, and if he possesses a sense of justice, must admit the absolute inadequacy of the present system of water rates. It must be brought home to the general public that an adequate water supply is one of the greatest essentials for the development of any community; and that to provide this a large investment for impounding works, filtration works, distribution system, etc., must be made. Upon the cost of this equipment, its operation and depreciation, the rate charged for water service must be based. The public is apt to forget that the water furnished here in Baltimore might almost be regarded as a manufactured product, for it must be filtered, deodorized if necessary, and all harmful bacteria destroyed and they cannot expect to continue to pay a nominal sum for a service when they are securing not only service, that is a supply of potable water brought to their premises, but are buying a commodity each unit of which costs a definite amount to so deliver.

Gas and Water Metering Compared.—Although at first the comparison seems far-fetched, upon consideration a complete analogy between the water supply and the gas supply can be established, and any argument in favor of gas meters is equally applicable to the sale of water. Gas is used everywhere as a source of heat for preparing food, for illumination, and in a lesser degree for heating. As the volume used is measured, the housewife is careful to use it only in such quantities and as long as the occasion demands, and then turns it off. The fact that gas is comparatively costly does not prevent its use for all legitimate purposes, and it does prevent its waste. The opponents of water metering constantly produce as a climax to their arguments the statement that metering will endanger the health of a community as the use of the water for washing, bathing and all household purposes will be rigidly curtailed. This is untrue. It will limit the use of water to necessary uses only, but will also prevent the continuance of the innumerable small house leaks which now occur. The comparison which I wish to make is that selling water on a metered basis will no more cause ill health through the excessive reduction of its use than does the sale of gas on a metered basis cause cold and unlighted homes and insufficiently cooked food.

The Department's estimate that universal metering will decrease the consumption twenty per cent is based upon the elimination of this house waste and a somewhat curtailed use of water. We have no desire to hamper in any manner the consumer's use of water as we will gladly sell any quantity he may desire, but we do wish to discontinue the present practice of a householder paying merely a nominal sum and then wasting water worth several times the revenue which we receive.

How Metering Will Affect Taxes.—It is comparatively easy to conceive in what manner a decrease in the water consumption will decrease the tax rate. The only thing necessary is to follow the water from the impounding dam at Loch Raven to the Filtration Plant at Montebello, where it is pumped, filtered and purified, then to the various parts of the City which require another pumping and in some cases a re-pumping to a higher level, and then after its use as wash water; or perhaps merely as a flow from a leaking spigot, its discharge into the sewer system and

Table XII—Relation of Water and Tax Rates for Properties of Various Widths

Width of Property in Feet cut	Average Assessed Value of House	Present Tax Rate	Total Taxes	Tax Rate With Water Dept. Self-Sustaining	Total Taxes	Saving in Tax Rate	Present Flat Rate Water Rent	Approx. Minimum Charge	Additional Payment Necessary
12	$1,600	$2.97	$47.52	$2.82	$45.12	$2.40	$3.25	$12.50	+ $6.85
13	1,800	2.97	53.46	2.82	50.76	2.70	5.00	12.50	+ 4.80
14	2,100	2.97	62.37	2.82	59.22	3.15	6.50	12.50	+ 2.85
15	2,500	2.97	74.25	2.82	70.50	3.75	7.50	12.50	+ 1.25
16	3,000	2.97	89.10	2.82	84.60	4.50	9.00	12.50	— 1.00
17	3,500	2.97	103.95	2.82	98.70	5.25	11.50	12.50	— 4.25

then its final pumping to the Back River sewage disposal plant. Reduce the initial quantity of water required in the City a certain proportion and a corresponding proportion of the expense of all the subsequent operations will follow. It is this reduction of operating expenses—together with the increased revenue of the Water Department and the corresponding elimination of an appropriation to make up the deficit now caused by insufficient revenue—which will cause a decrease in the tax rate.

Metered System and Landlord and Tenant.—There has been much discussion about the effect of a completely metered system upon landlord and tenant. A report of the Committee on a Survey of Housing Conditions dated March 1, 1921, gives the following statistics concerning owned and rented houses:

District	Occupied by Owner	Rented	Vacant—Probably Rented	Total Dwellings	Percent of Homes Owned	Rented
Northern	12,097	4,048	517	16,662	74.9	25.1
Northwestern	14,895	12,013	416	27,324	55.3	44.7
Northeastern	21,023	9,398	486	30,907	69.1	30.9
Eastern	13,106	4,361	237	17,704	75.0	25.0
Western	1,921	4,530	76	6,527	29.8	70.2
Central	1,929	2,103	113	4,145	47.8	52.2
Southern	5,486	5,975	141	11,602	47.9	52.1
Southwestern	9,969	6,587	284	16,840	60.2	39.8
Total	80,426	49,015	2,270	131,711	62.2	37.8

Of the total of 131,711 houses, 80,426 are occupied by the owner and 51,285 are rented (49,015 plus 2,270 vacine, presumed to be for rent). It appears that consideration need only be given the rented houses, as the houses occupied by owners are not affected. It is assumed that within a year all adjustments between owner and tenant can be made as to the legitimate use of water, for the experience of the private water companies proved that this is an individual problem.

House Frontages and Water Costs.—On December 31, 1919, there were according to the records of the Collector of Water Rents and Licenses, 27,659 12-ft. front houses, 19,746 13-ft., 30,027 14-ft., 17,088 15-ft., 8,966 16-ft., and 4,610 17-ft. front houses, paying water rents of $3.25, $5.00, $6.50, $7.50, $9.00 and $11.50, respectively, or a total of 108,096 houses paying a total of $645,666.25. Houses 18-ft. and over in width will hardly pay more than the rate established by the Department, considering a 30-gallon per capita consumption.

It must be borne in mind that an adjustment of the water rates is necessary, even if the flat rate system is maintained, if the Water Department be made self-sustaining. To retain low rates on the smaller width houses and to increase the rental on the wider frontages would be inequitable and create difficulties, as any consumer can obtain an injunction to restrain the Water Department from charging inequitable and exorbitant rates. This was recently done by garage owners where flat rate charges were assessed, resulting in a decision of the Water Board to meter all garages over 2,000 square feet in area.

Making the Water Department self-sustaining would decrease the tax rate from $0.13 to $0.15, assuming $0.01 on the tax rate produces approximately $70,000.00 revenue. At the present time consumers paying water rents more than $12.50 are paying in their tax rate amounts to cover the deficit in the Water Department created by supplying properties paying less than this rental. In 1922 this deficit amounted to approximately $831,000.00. Table No. 12 shows the amount assessed as taxes on houses from twelve to seventeen feet front and the additional amount necessary should an approximate fixed rate of $12.50 be applied.

(Part II will be continued in the Oct. 10 Engineering and Contracting.)

Blasting Drilled Wells.—A pamphlet entitled "Blasting Drilled Wells to Increase the Flow of Water," by S. R. Russell, C. E., has just been issued by E. I. du Pont de Nemour & Co., Wilmington, Del. The pamphlet embodies the result of studies made extending over a great number of years.

Comparison of Flood Control Measures

The Causes of Floods and Methods for Their Control Outlined in Address Before American Association for the Advancement of Science

By HARRY TAYLOR,
Brigadier-General, U. S. A., Assistant Chief of Engineers

It may be well to ask at the outset what are the causes of floods? The answer is, briefly, abnormal rainfall. This rainfall may be either in the shape of what is popularly known as a "cloudburst," such as occurred at Pueblo, Colo., in June, 1921; in the shape of heavy, long-continued rains, such as produced the floods in the lower Mississippi River in February and March, 1922, or heavy rains falling on snow or frozen ground, such as produced the floods which devastated Dayton and other cities of Ohio a few years ago.

Warm winds blowing on a heavy blanket of snow may also produce a serious flood. Floods of this character are most common in the Pacific Northwest where a warm southwest wind, known as a "Chinook" wind, occurs during the winter months and causes the snow on the mountains to melt with great rapidity.

The floods caused by the so-called cloudburst are usually local in character and commonly occur on small streams. Floods caused by long, heavy rainfall usually cover a large territory and it often happens that such rainfall will produce a flood in the main stream when none of the tributaries is subject to excessive flood. This occurred recently in the lower Mississippi, when that stream carried an unusual flood, but all of the lower tributaries carried moderate quotas. The floods caused by rains falling on snow or frozen ground generally affect an area intermediate between the other two types.

Little Thought Given to Control of Floods.—Outside of the Mississippi Valley the people of the United States ordinarily give little thought to the control of floods. It is only when some serious flood occurs that attention is focused on the prevention of a repetition of the disasters caused by such flood, and then the matter is of extreme interest for a short time, with all sorts of remedies proposed. Dayton, O., is one exception.

It is characteristic of the American people that when we suffer from any cause such as a flood, a contagious disease, or war, we are wildly enthusiastic for steps to prevent a repetition of the disaster, but as soon as the time of stress has passed, we forget that trouble has occurred and delay taking the steps necessary to prevent a repetition.

This is well illustrated by the present attitude of the American people toward the army. Five years ago there was nothing too good for the army. Today, many seem to desire its absolute abolition, forgetting that it is an insurance against trouble in the future. I wish I could believe that we will never be involved in another war. I wish also that I could believe that we will never have a disastrous flood, but I am certain that floods will come until we know how to control the distribution of rainfall, and I am equally certain that the services of the army will be required in the future.

The control of floods appears to be considered by the majority of our people as a simple problem. It is true that different people have different solutions. The most common solutions are reforestation, reservoirs at the sources of streams, levees, outlets or spillways, and straightening and enlarging river beds. We frequently have other solutions suggested, as for example, one proposed to install boilers on the banks of the Mississippi River to evaporate the flood waters, thus causing clouds to form and produce rain over the Middle West where needed.

In the solutions proposed, the control of floods is quite commonly linked with other beneficial effects, most commonly with waterpower development. It is generally assumed that the same work which will control floods will produce power, improve navigation, and provide drainage.

One very troublesome problem that comes before the engineer department is the problem of the Fox River and Lake Winnebago, Wis. At the outlet

of Lake Winnebago are constructed two dams with gates for controlling the water outflow from this lake. The lake is surrounded by flat land over which the flowage rights were purchased and paid for by the United States some 50 years ago. Since that time these lands have been sold and the buyers in many cases have apparently made their purchases unaware of the rights of the government. Invariably, during floods on this stream, the people above the dams insist on the gates being open so as to permit the water to flow out rapidly; the people below the dams insist on the gates being closed so as to prevent the water from coming down on them; power interests on the lower river desire to have the water retained and released during periods of low water for the purpose of developing additional power; for the benefit of navigation, the flow should be as uniform as possible.

With reference to reforestation. I desire to say that I am a thorough believer in a sensible and sane system of reforestation. I believe that the proper exploitation of our few remaining forests and intelligent reforestation is one of the great needs of the country. Reforestation has sufficient merit in itself to stand on its own feet and should not be confused with flood control. The price of lumber today is a sufficient argument for planting trees without attempting to associate forestry with the climate or with flood conditions on our rivers.

Influence of Forests on Stream Flow.—There appears to exist in the public mind an impression that the prime cause of floods in this country has been the destruction of the forests, and that the surest way to prevent them is by reforestation. The influence of forests on stream flow has been extensively discussed both by European and American engineers since Gustave Wex, imperial and ministerial counselor and engineer of the improvement of the Danube River at Vienna in 1873 submitted a series of papers on the decrease of water in springs, creeks and rivers which were translated into English by the late General Weitzel, C. E.

There is a great diversity of opinion on the subject, some maintaining that the cutting of forests will ultimately convert Europe into a Numidian desert, while others claim that a moderate cutting of the forests even increases the rainfall. Whatever may be the theoretical principles involved, their practical application is fraught with great difficulty.

When a country acquires a population of 100,000,000 people, the forest primeval which existed when it was settled has to disappear. It is all very well to bemoan the fact that if the black walnut which once covered the state of Ohio had not been destroyed and was sold as lumber at the present market rates, it would equal the assessed valuation of the property of the state, but there have now been created the cities of Cleveland and Cincinnati, whose people can not live on black walnut alone, but require grain and meat. The black walnut of Ohio has gone, never to return, and the same is true of the forests in other sections of the country.

The fertile lands will not be taken away from the farmer. They are too valuable for raising potatoes and hogs. Only the poorer soils can be used for forest culture, and only a limited reforestation, then, is possible.

The effect of forests on rainfall in Europe has been carefully investigated and the records at many European localities, where the rain has been recorded for long periods, fail to show any tendency to a pronounced change of fall in recent years.

The Merrimack River Studies.—The meteorological records of the United States have not been maintained a sufficient length of time to be of much value in solving the problem. The best existing data in this country of which I am aware are those for the Merrimack River, on which a daily record of the stage of the river has been observed since 1849, on a gauge established below the dam at Lawrence, Mass. An exhaustive study of this stream was made about 12 years ago by Col. Edward Burr, C. E., and a report submitted by him which is published as a government document. Colonel Burr's conclusions as summarized for the basin of the Merrimack River were as follows:

"Deforestation of the basin continued progressively from the early settlements until about 1860-1870, and since that period forested areas have increased through natural causes by 25 per cent or more of the entire basin, notwithstanding the continuance of lumbering operations.

"There has been no decrease in pre-

cipitation in the basin as a result of deforestation or any increase with the reforestation of 25 per cent or more of its area. The precipitation for 50 to 90 years at points within the basin or within a few miles of its borders shows tendencies, or cycles, that bear no relation to the change in forest areas.

"The average run-off through the river varies with the precipitation over its basin, and the percentage of run-off to precipitation is not appreciably affected by forest changes as great as 25 per cent or more of the basin. The frequency of floods has not been decreased by reforestation or increased by deforestation.

"Exceptionally high floods have occurred at intervals without respect to forest conditions. Flood heights have not been decreased by forestation or increased by deforestation, and the principal characteristics of floods are unaffected by forest changes. The duration of flood stages and the amount of run-off during such stages have not been affected adversely by deforestation or beneficially by reforestation.

"Deforestation has not lessened the height of the river at low water or increased the duration of low-water periods, and the reforestation of 25 per cent or more of the basin has not had any beneficial effect on low stages of the river.

"Variations in stream flow are determined essentially by variations in climatic conditions which move in irregular cycles independent of forest changes. Correct deductions as to climatic variations and as to varying conditions of stream flow may be expected only from the analysis of satisfactory records covering periods of 60 years or more, and conclusions drawn from records extending through 40 years or less may, and probably will, be misleading or incorrect."

Reforestation as a Means of Reducing Flood Heights.—The greatest flood of the Mississippi at St. Louis occurred in 1844; the next largest in 1875. On the Great Lakes the high water of 1838 is the greatest on record. On the Ohio, the flood of 1884 exceeded that of 1913 at Cincinnati; and that of 1832, while 5 ft. lower at Cincinnati, was 5 ft. higher at Pittsburgh than the 1913 flood. The gauge records at the bridges over the upper Mississippi which cover a period of 30 years, would indicate that the flow from Minnesota and Wisconsin, where the forests have been most extensively destroyed during the period, has been slightly improved, though the river shows signs of deterioration where it receives the flow from the prairie lands of Iowa and Illinois. They appear to confirm the conclusion of the European forestry authorities that the influence of forests on drainage is concealed by other causes more powerful in their effects.

It is argued by some that if the floods were occasionally high, they would not be as frequent with reforestation. Again let us search the records of the past. It is hopeless to expect to reproduce by reforestation the forest growth that existed at the close of the Civil War. Yet, from 1857 to 1867, the Mississippi Valley was visited by a most remarkable series of great floods. These floods occurred as frequently as any that have been recorded since that time.

It requires from 20 to 50 years to produce a good forest growth, and over a century for the leaves of that forest to decay in sufficient quantities to produce the humus which will be satisfactory as an absorbent of rainfall. We are more vitally interested in the height that a river will attain in the next few months than in what will occur in the year 2022 or 2072.

Reforestation as a means of reducing flood heights on the Mississippi River, for example, requires the conversion of too much farm land into a wilderness to be practicable. The waste land can profitably be converted into forest reservations is too limited in area to produce an appreciable effect on the floods.

Flood Control by Reservoirs.—Next to reforestation, reservoirs as a means of controlling floods appear to have the most advocates. The reservoir theory is particularly attractive, as we have before us in the Great Lakes a practical illustration of flood restraint by means of natural reservoirs. Reservoir control of the Mississippi was discussed by Humphreys and Abbot in 1858, and on the upper Mississippi the Corps of Engineers has constructed the largest system of reservoirs for regulating rivers that has been built in any country. These reservoirs have been most successful, not only for increasing the low-water discharge of the Mississippi River above St. Paul, the purpose for which they

were constructed, but also for reducing floods in that portion of the river.

There is nothing novel in the proposition to control rivers by reservoirs. We have not only studied its advantages, but we know its limitations. Conditions are extremely favorable for reservoir construction at the headwaters of the Mississippi, but while they materially increase the low-water discharge at St. Paul and markedly reduce flood heights, yet 100 miles farther down the river it is impossible to detect their influence during either high or low water.

A reservoir must be close to the locality to be benefitted or its value rapidly diminishes, and this is a serious trouble with any project for regulating the lower Mississippi by reservoirs.

Reservoir Problem on the Mississippi.—To have retained the Mississippi flood of 1912 within its banks would have required a reservoir in the vicinity of Cairo, Illinois, having an area of 7,000 square miles, slightly less than that of the state of Massachusetts, and a depth of about 15 ft., assuming that it would be empty when the river attained a bank-full stage.

Cairo is the logical location for a reservoir to regulate the discharge of the lower Mississippi. It will not only control the floods from the Ohio, but also the discharge from the Missouri and upper Mississippi But if the reservoirs be transferred from the mouth of the tributaries to the headwaters, their capacity must be largely increased. No two floods have the same origin, unless they are referred back to the Gulf of Mexico. If the prevailing winds in the early spring are from the Southwest, the southern tributaries of the Ohio furnish the crest of the year's flood; if more nearly from the South, reservoirs will be required on the streams of Ohio, Indiana and Illinois; a slight varying of the wind will produce a flood in the upper Mississippi while, if it blows from the Southeast, the principal sources of trouble will be the Red, the Arkansas and Missouri Rivers. To control the flow of every stream in the Mississippi Valley by reservoirs is a pretty large job, even for the United States government, but that is what the control of the Mississippi during floods by reservoirs signifies.

The 1913 flood affords data for determining the effect of such a system of reservoirs. When, on April 2, 1913, the gauge at Cairo attained a height of 54 ft., there was flowing down the Mississippi River at least 2,000,000 cu. ft. of water per second. It requires about 11 days for a flood wave to be transmitted the 966 mi. between Pittsburgh and Cairo. On March 22, the Pittsburgh gauge read 5.3 ft., which is produced by a flow in the Ohio River at that locality of about 15,000 second-feet. In 10 days a flood travels the 858 mi. between St. Paul and Cairo. On March 2, the reading of the St. Paul gauge was 0.5 ft., corresponding to a discharge of the Mississippi of about 2,500 second-feet. In 8 days the effect of a flood at St. Joseph, Mo., is felt at Cairo. On March 25, the gauge at St. Joseph read minus 0.1 ft., representing a discharge of the Missouri River of about 17,000 second-feet. If a system of reservoirs had been constructed which would have prevented all flow from the Allegheny, the Monongahela, the Mississippi above St. Paul, and the Missouri above St. Joseph, it would have reduced the 2,000,000 second-feet discharge by the Mississippi River at Cairo on April 2 less than 35,000 second-feet.

The water which passed Cairo on the 2d of April came principally from the White and Wabash and the lower tributaries of the Ohio, and after the water of these rivers started to subside, the flood from Cincinnati, though increasing from 57 to 69 ft. on the Cincinnati gauge, could increase flood heights at Cairo less than 1 ft. The flood of 30 ft. at Pittsburgh on March 28 produced its effect on the Cairo gauge on April 8. It prolonged the flood without increasing its height.

The proposed system of reservoirs would have cost hundreds of millions of dollars, and its effect on the flood height of the lower Mississippi could not possibly have exceeded 6 in.

General Limitations on Reservoirs.—Great floods do not arise from average conditions, but from exceptional conditions such as are caused by heavy rains rapidly succeeding one another. Each rainstorm starts down a stream a flood, the volume of which can be absorbed by a reservoir with comparatively little trouble, but if a second storm sweeps over the valley the reservoir, to be effective, must be emptied or its capacity doubled. To hold all the excess rainfall till low water would require reservoirs of

enormous capacity. Economic considerations usually require that the reservoirs should be emptied as soon as the flood crest passes, in order to utilize the same space for a second rainfall; so that while reducing the crest of a flood at a given locality they necessarily prolong the period during which the river remains at a high stage.

Reservoirs are necessary for municipal water supplies, for purposes or irrigation, for the development of power, and for feeders to canals. They can be successfully employed on small streams to diminish floods or increase the low water flow. The trouble arises when an attempt is made to utilize them for too many purposes at the same time. There must be a paramount issue to which the others will be subsidiary.

If the main purpose is to supply a city with water, as a rule only the excess can be used for power development. In the case of the new San Francisco water supply, now under construction, a large amount of power will be developed, but in this case the main storage reservoir is over 4,000 ft. above the city and the topography is such that at one point the supply line drops about 1,300 ft., and at another point it drops 1,000 ft. in a nearly vertical line, giving an excellent opportunity for a power development at a minimum expense and without interfering with the main object of the construction. If the dams are constructed to produce power, the reduction of floods and the improvement of river navigation must be subordinate thereto. Water required for irrigation can be used to develop power when the dam of the storage reservoir is given a greater height than is necessary for its flow over the land to be reclaimed.

During the next decade there will be an enormous development of reservoirs, both for irrigation and for power purposes, which I hope will be utilized to correct man's folly and prevent many disasters similar to those which have occurred in the past.

Levees as Flood Protection Measures.—Levees, properly located and constructed, are an effective means of protection against floods. Levees have been used for many years on the European rivers and to a great extent for the protection of the lands bordering the Mississippi River. At the present time there are 1,779 mi. of effective levees in place between Rock Island, Ill., and the mouth of the Mississippi. These levees contain about 400,421,000 cu. yds. of material. The levee system protects about 27,628 sq. mi. of land. At the present time, the question of providing additional outlets or spillways on the lower Mississippi is being given great consideration. That the spillway will cause a temporary lowering of the flood water is beyond question, but it is not quite so certain that the ultimate effect of a spillway will be beneficial to the Mississippi, for there is a possibility that the abstraction of the water will cause shoaling of the channel below the spillway, which may produce serious results in time. Levees combined with channel enlargement and spillways are being used in the flood control of the Sacramento River. The spillways, however, are of secondary importance, the main dependence being placed upon levees and the straightening and enlarging of the channel of the river near its mouth, so as to afford a freer escape of the flood waters.

In locating levees, care must be exercised not to place them so near the banks of the river as to unduly crowd the stream and reduce the cross-sectional area sufficiently to prevent the escape of flood waters without causing their rise to such a height that they will overtop the levees. The great tendency is for the owners of the land on each side of the stream to crowd the levee as close to the bank of the stream as possible, leaving too little space for the escape of flood waters, with disastrous results to both sides.

Annual Meeting of Iowa Section of American Water Works.—The 9th Annual Meeting of the Iowa Section of the American Water Works Association, will be held at Ames, Ia., Oct. 24th-5th-6th, with headquarters at Iowa State College. Immediately preceding the meeting of the Iowa Section will be held the 5th Conference on Sewage Treatment, which will begin on Oct. 22nd. Those members of the section who are interested in sewage treatment are invited by the Iowa State College to attend the conference. Prof. Jack J. Hinman, Jr., State University of Iowa, Iowa City, Ia., is Secretary of the Iowa Section.

Economies in Cleaning Irrigation Canals

How the Work Is Handled on the Boise Project of the U. S. Bureau of Reclamation, Described in the Reclamation Record

By C. L. TUCKER
Assistant Engineer, U. S. Bureau of Reclamation

The project is divided into four water master's divisions of approximately 36,000 acres each. The water masters have direct charge of all operation and maintenance forces within their territory and act as superintendents on maintenance work. The cleaning foremen are selected from among the ditch riders. It is possible to drive with an automobile along or on the banks of all canals and along practically all of the laterals. The structure numbers represent the distance the structure is from the head of the canal or lateral. These conditions allow inspection to be made rapidly and without difficulty. On large canals it is possible to inspect from 20 to 25 miles in one day.

The description of organization of forces and the supervision of work is for convenience divided into the following headings: Inspection, Records, Silt removal, and Results.

Inspection.—The water master, in company with the writer, inspected the canals and laterals of his division. Notations were made directly on a chart as to what should and should not be cleaned. If the work was exceptionally heavy, an "H" was shown in the record of the portion to be cleaned. If exceptionally light, an "L" was shown. The chart is explained later under the heading "Records." When inspecting canals considerable benefit is derived other than that relating to the cleaning. On this project, in order that pressure might be maintained on headgates, it has been necessary to install checks in canals of shallow depths. These checks naturally decrease the velocity, resulting in heavy silt deposit and moss growth. It is the tendency of most cleaning foremen and even some water masters to gouge the bottom and sides of canals of this character, especially if they have knowledge of any trouble during the previous water season. This kind of cleaning is expensive and increases the trouble rather than overcoming it. If the canals are widened, the velocity is naturally decreased with a given quantity of water. When conditions of this kind are found, the bottom of the canals is allowed to narrow and all silt is being put on the banks. Eventually the water depth and velocity will be increased until little checking is required. This will eliminate to a great extent moss growth and silt deposit. The water master and irrigation manager also become familiar with the system and secure first-hand information as to the condition of structures and weak places in the canal banks. At the time of cleaning, such banks can be strengthened or riprapped which will probably prevent a break the following season. The water master is more capable of judging what requires cleaning than the cleaning foreman. If the water master is in any doubt as to the grade of

Form No. 5—Canal Cleaning Costs, Detailed Estimate After Inspection, Division "Sample"

Canal or lateral	Class A Canals: *Total stations	Class A Canals: Stations inspected	Class A Canals: Stations to clean	Class B Laterals: Total stations	Class B Laterals: Stations inspected	Class B Laterals: Stations to clean
Waldvogel	668	568	275	362	362	184
North Power	.....	.....	.....	220	.....	.....
Siphon	.....	.....	.....	50	50	20
South Power	.....	.....	.....	214	214	62
Dirkman	.....	.....	.....	41	41	12
Butte	.....	.....	.....	114	114	47
Flume	.....	.....	.....	132	132	59
North McElroy	.....	.....	.....	79	70	0
Sol	.....	.....	.....	20	20	0
Hyer	.....	.....	.....	24	24	5
South McElroy	.....	.....	.....	53	53	18
Delta	.....	.....	.....	29	29	0
Torrence	.....	.....	.....	18	18	0
Demke	.....	.....	.....	136	.....	.....
Total (89 other items omitted)	2,515	1,543	275	8,355	2,798	739

*Stations each 100 ft. in length.

certain sections, grade stakes are furnished by the engineers. It is undoubtedly a fact that without such supervision thousands of dollars would be expended each year for cleaning canals the bottoms of which were already below the original grade.

Records.—As a foundation for cleaning records a chart was prepared on which all canals and laterals in each water-master's division are shown. A miniature chart (Chart No. 1) is shown in the accompanying illustration. The original chart is plotted to a scale sufficiently large to show each station. A copy is kept in each water-master's office as a reference, showing the status of canals and laterals, such as end of Government construction, Government operation, or Government maintenance. At the time of inspection any portions of the ditch not requiring cleaning are blocked in solid with a colored pencil. The remaining portions are left blank and filled in, as shown on the chart illustrated, as the cleaning progresses. At the end of the season's work these charts can be filed for future reference. Form No. 5 is used for assembling the estimated cleaning. The canals and laterals are divided into two classes and each class is estimated separately. Before adopting the present system it was nearly impossible to estimate cleaning costs with any accuracy. During the past season in one water-master's division and after 4,341 stations out of 10,870 stations had been inspected it was estimated that it would be necessary to clean 2,540 stations at a cost of $4,205.08. When cold weather caused a suspension of the work, which was practically completed, 2,301 stations had been cleaned at a cost of $3,858.31, or within 1.1 per cent of the estimate.

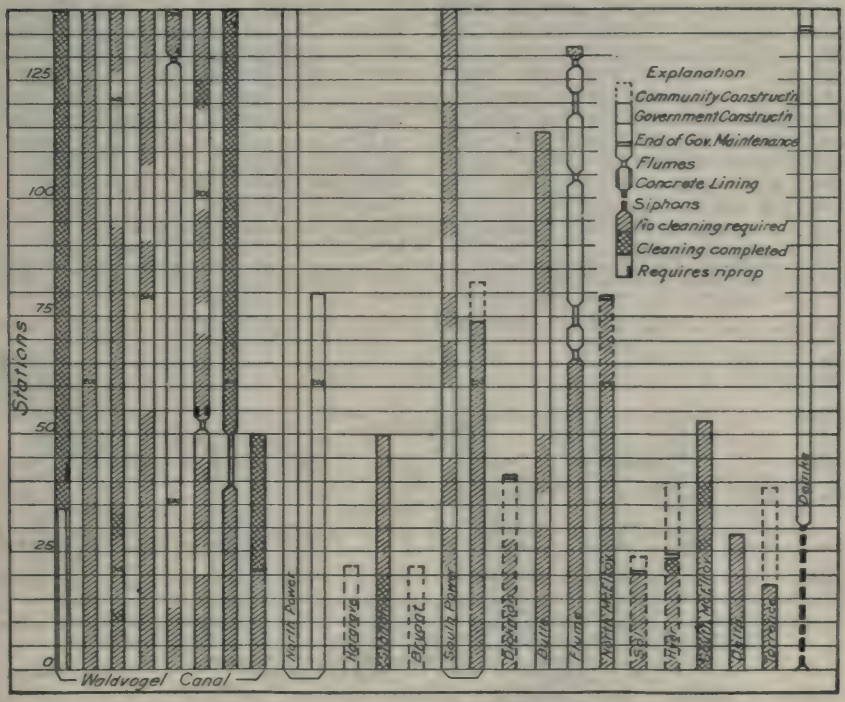


Chart No. 1.—Condition of Canal and Status of Cleaning Operations, Boise Project, Idaho.

As the work progresses each foreman's results are segregated in the water master's office and submitted weekly to the writer. If any foreman's costs greatly exceed the estimate his work is immediately investigated. Sometimes it is found that the work is heavier than estimated or that the foreman is using slips

where he should use fresnos, or the reverse. Usually, though, it is found that the foreman is using more teams than is economical. Each water master has from 10 to 15 cleaning crews working simultaneously, and it is well to know immediately if any are exceeding the estimate. The results reported weekly by each water master are summarized in the office and the totals are shown on Form No. 4, which shows the progress as well as comparative costs. At the completion of the cleaning season Form No. 3 is prepared, which summarizes the total stations cleaned and the cost by foremen. The foremen are grouped under their respective water masters and are arranged according to the unit cost of their work. The totals shown on Form No. 3 are carried to Form No. 1, and are arranged according to unit costs. On this form the water master cleaning at the lowest cost is given a standing of 100 per cent. The others are rated, using the cost which is given 100 per cent as a basis. This form also compares the actual cost with the estimated cost for the entire project. Form No. 2 shows the standing in percentage of each foreman, taking the project as a whole. For determining the basis of percentages an average cost was taken from one-half of the total stations cleaned at the lowest costs.

Silt Removal.—From Chart No. 1, or Form No. 5, the water master groups the cleaning work in a certain locality and furnishes the foreman with a work order which shows exactly the portion of each canal he is to clean. The water master knows from the classification about how many teams the foreman can use economically. It has been found by comparison that not more than from three to five teams can be used to advantage on small laterals. The foreman on this size crew takes the place of one

Form No. 4—Canal Cleaning Costs, Estimate and Progress, Division C

ESTIMATE

Total stations in division	10,870
Inspected to date	4,341
Inspected stations that require cleaning	1,014
Estimated total to clean $\frac{1,014}{4,341} \times 10,870$	2,540
2,540 at $1.53	$3,886.20
Weir pools	$318.88
Total	$4,205.08

PROGRESS

Date	Stations	Cost Total	Cost Unit	Per Cent Complete Cost	Per Cent Complete Stations	Weir Pools No.	Weir Pools Cost
To Oct. 31, 1922	97	$161.16	$1.66	4.1	3.8	.....	$258.63
Nov. 1 to 10, 1922	947	1,342.00	1.42	34.6	37.3	.....	23.50
Total	1,044	1,503.16	1.44	38.7	41.1	.....	282.13
Nov. 11 to 20, 1922	846	1,474.72	1.74	38.0	33.3	.....	29.25
Total	1,890	2,977.88	1.57	76.7	74.4	.....	311.38
Nov. 21 to 30, 1922	411	561.55	1.37	14.5	16.2	.....	7.50
Total	2,301	3,539.43	1.54	91.2	90.6	.....	318.88

Form No. 3—Canal Cleaning Costs, Division C Summary, 1922

Foreman	Class A Canals Station	Class A Canals Cost	Class A Canals Unit Cost	Class B Laterals Station	Class B Laterals Cost	Class B Laterals Unit Cost	Weir Pools No.	Weir Pools Cost
1	101	$392.09	$3.88	.....	.....	.....	.....	.....
2	4	29.67	7.42	.....	.....	.....	.....	.....
3	.....	.....	.....	53	$53.42	.....	.....	.....
4	.....	.....	.....	251	317.83	1.27	34	.....
5	.....	.....	.....	269	343.00	1.27	20	15.00
6	.....	.....	.....	274	351.33	1.28	24	28.67
7	.....	.....	.....	290	379.22	1.31	16	11.50
8	.....	.....	.....	230	304.63	1.32	11	8.25
9	.....	.....	.....	98	143.00	1.46	.....	.....
10	.....	.....	.....	216	321.44	1.49	.....	.....
11	.....	.....	.....	500	873.80	1.75	288	160.26
12	.....	.....	.....	15	30.00	2.00	16	12.00
13	.....	.....	.....	.....	.....	.....	87	57.86
Total	105	$421.76	$4.02	2,196	$3,117.67	$1.42	436	$318.88

SUMMARY

Class A canals: 1.99 miles; cost, $211.94 per mile.
Class B laterals: 41.60 miles; cost, $74.94 per mile.
Estimated stations to clean: 2,540.
Cleaned: 2,301, or 90.6 per cent.
Estimated field cost: $4,205.08.
Actual cost to date: $3,858.31, or 91.7 per cent.

single hand. Where larger crews are used it often becomes necessary to move several times during the day. The time taken for moving is absolutely a loss. With smaller crews are required to go to and from work on their own time, this eliminates a move during working hours. A large saving can be made by inspecting the ditches before the commencement of

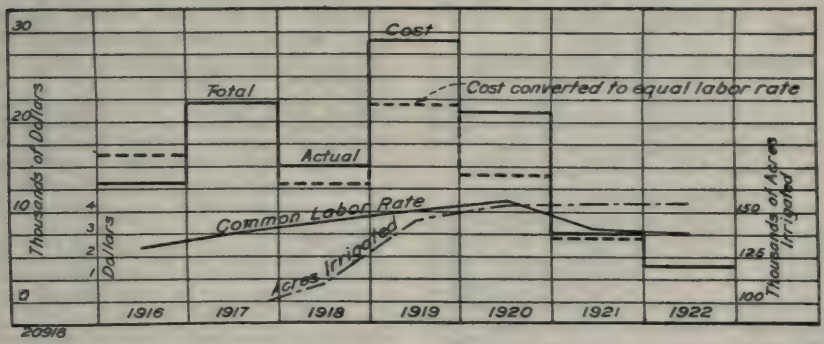


Chart No. 2.—Cost by Years of Removing Silt From Canals and Laterals of One Division, Boise Project, Idaho.

less moves will be made per thousand feet of lateral cleaned. Long moves can be arranged to occur at the end of the day's work. As cleaning crews cleaning operations. Under the present system the foreman is credited with only the actual stations cleaned and not the distance traveled. If the

Form No. 1—Canal Cleaning Costs, Total Summary, 1922

		Class A Canals			Class B Laterals			Weir Pools	
Division	% Effic.	Station	Cost	Unit Cost	Station	Cost	Unit Cost	No.	Cost
A	100	440	$1,283.34	$2.92	.....	.....	.....	.....	.....
B	77	45	170.29	3.79	.....	.....	.....	.....	.....
C	73	105	421.76	4.02	.....	.....	.....	.....	.....
C	100	.....	.....	.....	2,196	$3,117.67	$1.42	436	$318.88
A	94	.....	.....	.....	922	1,397.59	1.52	192	146.00
B	63	.....	.....	.....	624	1,408.90	2.26	62	46.97
Total	.....	590	$1,875.39	$3.18	3,742	$5,924.16	$1.58	690	$511.85

SUMMARY

Class A canals: 11.18 miles; cost, $167.75 per mile.
Class B laterals: 70.88 miles; cost, $83.58 per mile.
Estimated stations to clean: 6,270.
Actually cleaned to date: 4,332; per cent completed, 69.2.
Estimated field cost: $12,358.18.
Actual cost to date: $7,799.55; per cent of estimate, 63.1.

Form No. 2—Canal Cleaning Costs, Relative Efficiency of Foremen, 1922

Foreman	Division	Station	Cost	Unit Cost	% Effic.
	CLASS A CANALS				
1	A	105	$236.00	$2.25	124
2	A	66	150.88	2.27	123
3	B	27	61.83	2.29	122
4	A	8	21.00	2.63	106
5	A	88	264.50	3.01	92
6	A	149	484.06	3.25	86
7	C	101	392.09	3.88	72
*Total	---	590	$1,875.39	$3.18	.....
	CLASS B LATERALS				
1	C	53	$53.42	$1.01	132
2	A	115	117.25	1.02	130
3	A	90	103.14	1.15	116
4	C	251	317.83	1.27	105
5	C	269	343.00	1.27	105
6	C	274	351.33	1.28	104
7	C	290	379.22	1.31	102
8	C	230	304.63	1.32	101
9	B	43	61.17	1.42	94
10	A	183	261.18	1.43	93
‡Total	---	3,742	$5,924.16	$1.58	.....

* 5 other items omitted for lack of space.
‡ 16 other items omitted for lack of space.

cleaning is very light and scattered, smaller crews are used. No trouble is experienced on this project in securing teams from water users, and as it is the policy to apportion the work among as many farmers as possible, those living nearest the work are employed.

Results.—The present method of supervising cleaning work was put into effect during the fall of 1921. The accompanying table shows a comparison of costs between the work done in the fall of 1921 and 1922.

Unit Cleaning Costs, by Teams

	Class A Canals		Class B Laterals	
Year	Miles	Unit Cost	Miles	Unit Cost
1921 (fall)	5.85	$247.00	70.33	$120.00
1922 (fall)	11.18	167.75	70.88	83.58

The wage scale during the falls of 1921 and 1922 was the same. The 1922 results show a saving over 1921 of 32 per cent on the canals and 30 per cent on the laterals. The work was better organized in 1922 and the water masters and foremen, realizing that their efficiency was to be rated, desired to at least make a good showing. For a matter of further comparison a chart (chart No. 2) has been prepared and is also illustrated. This chart shows the total cost by years of removing silt from the canals and laterals of one division. The present method of supervision was put partly into effect in this division in 1920 and fully into effect during the years 1921 and 1922.

Per Capita Water Consumption in Metropolitan Water District

Water consumption in the Metropolitan Water District of Massachusetts, in order of per capita consumption, beginning with the lowest, was as follows for the year 1922:

	Gallons		Per Ct.
City or Town	Total Per Day	Per Cap. Per Day	Services Metered
Milton	436,000	45	100
Medford	2,193,400	51	100
Malden	2,698,000	53	97
Arlington	1,059,600	54	100
Winthrop	902,400	54	99
Belmont	673,200	57	100
	1,167,800	62	99
Stoneham	523,200	65	98
Lexington	440,000	66	99
Revere	2,202,200	70	82
Watertown	1,621,800	73	100
Swampscott	629,800	74	100
Chelsea	3,416,500	76	99
Somerville	7,357,300	76	82
Quincy	4,253,700	84	91
	3,648,900	86	75
Boston	85,871,000	110	65
Nahant	172,300	120	76
Total Dist.	119,267,100	94	77

The New England Water Works Association Convention

All indications point to a large attendance at the 42nd annual convention of the New England Water Works Association which is to be held Sept. 18-21 at Burlington, Vt. An excellent program of technical and practical papers has been prepared, and the space already taken for exhibits of water works machinery and appliances indicates that this feature of the convention will be unusually interesting.

The convention will be held in the Hotel Van Ness, the manufacturers' exhibit being in the main dining hall. The office of the Secretary will be open on the street floor of the hotel at 9 a. m., Sept. 18, for registration.

The program of the convention follows:

TUESDAY AFTERNOON, SEPT. 18th
2:00 o'clock

Addresses of Welcome:

Hon. J. Holmes Jackson, Mayor of Burlington. C. S. Ordway, President Burlington Chamber of Commerce.

Presentation of Honorary Membership to Mr. John Ripley Freeman.

Award of Dexter Brackett Memorial Medal.

"Filtration of Burlington's Water," by Oliver J. Channing, Pumping Engineer, Burlington.

Election of Officers.

WEDNESDAY MORNING, SEPT. 19th
9:15 o'clock

Public Water Supplies of Vermont, by Charles P. Moat, Chemist of Vermont State Board of Health, Burlington, Vt.

The Covering of Open Service Reservoirs in Which Filtered or Ground Water Are Stored, by George C. Bunker (in charge of Water Purification, The Panama Canal, Ancon, C. Z.) and August G. Nolte (asst. engineer in charge of Water Purification, The Panama Canal, Ancon, C. Z.). Presented by Robert Spurr Weston, Consulting Engineer, Boston, Mass.

Some Additions to New England Water Works Plants, by Allen Hazen, Consulting Engineer, New York, N. Y.

Sub-Surface Collecting System and Quality of Water of Newton, Mass., by Edwin H. Rogers, City Engineer, Newton, Mass.

WEDNESDAY AFTERNOON, SEPT 19th
2:00 o'clock

Rapid Sand Filtration at Cambridge, Mass., by Col. George A. Johnson, Consulting Engineer, New York, N. Y.

The Laying of the 16-inch Cast Iron Water Main Under Portland Harbor, by Harry U. Fuller, Chief Engineer, Portland Water District.

The Care of Large Water Sheds, by Frederic I. Winslow, Consulting Engineer, Framingham, Mass.

WEDNESDAY EVENING, SEPT. 18th
8:00 o'clock

Worcester's Reservoirs; Present and Pro-

posed, by George W. Batchelder, Water Commissioner, Worcester, Mass.

The Selection of Pumping Equipment From the Standpoint of Station Economy, by Frank A. Mazzur, Mechanical Engineer, Boston, Mass.

Some Applications of the Venturi Principle, by Frederick N. Connet, Chief Engineer, Builder's Iron Foundry, Providence, R. I.

SUPERINTENDENTS' SESSION

THURSDAY EVENING, SEPT. 20th
8:00 o'clock

Eliminating Water Hammer From a High Pressure Regulating Valve and Experiences With Universal Pipe on Curves, by Sydney Lee Ruggles, City Engineer, Barre, Vt.

Hydrant Connections for Fire Engines, by Frank A. Marston, Consulting Engineer, Boston, Mass.

Discussion of the following subjects, or others which may be presented: (Members are requested to present additional subjects to the Secretary at any time before the opening of the session.)

Standardization of Water Meter Registers.
Use of Brass Pipe for Services.
Protection of Water Mains Crossing Bridges.
Should Valve Boxes Be Placed at the Main or the Curb?
Experience With Power Tampers.
Experience With Valve Inserting Machine.
Standardization of Corporation Cocks.
Trenching and Back Filling Machines.

MANUFACTURERS' DAY

FRIDAY MORNING, SEPT. 21st
9:15 o'clock

The Manufacture of Wrought Iron Pipe, illustrated, by A. A. Gatheman, of A. M. Byers Co., Boston, Mass.

Testing, Maintenance and Operation of Large Gate Valves, by Payne Dean, of Payne Dean Limited, New York, N. Y.

Records of Stream Flow; Their Use and the Best Methods for Obtaining Them for Municipal and Industrial Purposes, by C. C. Covert, of W. & L. E. Gurley, Troy, N. Y.

Latest Developments in the Chlorine Control Apparatus for the Sterilization of Water Supplies, by Gilbert H. Pratt, New England Representative of Wallace & Tiernan Company, Newark, N. J.

FRIDAY AFTERNOON, SEPT. 21st
2:00 o'clock

Some Recent Developments in Steel Pipe, by H. T. Miller, Metallurgical Dept., National Tube Co., Boston, Mass.

Report of Secretary.
Report of Treasurer.
Report of Editor.
President's Address.

ENTERTAINMENT

The Local Committee of Arrangements and the Water Works Manufacturers' Association have arranged the following tentative program of entertainment:

TUESDAY, SEPT. 18th

At the close of the afternoon session electric cars will be taken to Fort Ethan Allen. By the courtesy of the Commanding Officer a cavalry drill and concert will be given.

Reception and Dance

Direction of Mr. Henry S. Charron

8:30 p. m. Informal reception with dancing on the roof garden of the Hotel Vermont.

The day's entertainment by the courtesy of the City of Burlington.

WEDNESDAY, SEPT. 19th

Afternoon Tea

Direction of Mrs. C. H. Beecher

For the Ladies—Afternoon tea on the Hotel Vermont Roof Garden, where wonderful views may be had of Lake Champlain, the Adirondack Mountains and Green Mountains.

WEDNESDAY EVENING

Whist Party

Direction of Mrs. Laura B. Landon
President of Athena Club

For the Ladies—A whist party on the Hotel Vermont Roof Garden.

THURSDAY, SEPTEMBER 20th

Excursion to Ausable Chasm

Direction of Mr. Burt B. Hodgman

8:30 a. m. Leave Burlington on the regular boat of the Champlain Transportation Co., arriving at the Chasm about 10:00 a. m. Visit to the Chasm, having dinner at the Chasm Hotel. Leave Chasm at 3:30 p. m., arriving in Burlington at 4:30 p. m.

Further information and details of the trip will be announced at the Wednesday evening session.

The day's entertainment by courtesy of the Water Works Manufacturers' Association.

FRIDAY, SEPT. 21st

Automobile Trip

Direction of Mr. Eben Sutton

Automobile trip for the ladies, covering the principal parts of the city and surroundings.

GOLF TOURNAMENT

R. K. Blanchard, Chairman of Committee.

One of the best short courses in New England is going to be available for all golfers attending the convention, and arrangements have been made for automobiles to carry the members from their hotels directly to the golf course.

The tentative schedule of events is as follows:

Tuesday Afternon, Sept. 18, 1923

Preliminary Handicap Tournament. Prizes will be given for best net and best gross score.

Wednesday Morning, Sept. 19, 1923

18 Holes Qualifying Round (Handicap) for match play. Eight to qualify in first division and eight in second division. Prizes will be awarded for best net and best gross score in qualifying round.

Wednesday Afternoon, Sept. 19, 1923

First round match play, both divisions, 18 holes.

Thursday, Sept. 20, 1923

On account of the boat ride which is a very attractive trip and which most of the members will want to attend, the finals will have to be played off on Friday morning, Sept. 21, 1923.

Friday Morning, Sept. 21, 1923

Final round, 18 holes, match play, both divisions. Prizes will be awarded to winner and runner-up in both divisions.

Water Purification in Illinois.—At the present time there are in Illinois 39 supplies subjected to fairly complete purification; 2 that are softened, 2 where iron is removed, 14 which are more or less continually sterilized by the use of liquid chlorine or hypochlorite, without coagulation or filtration, and 4 where sterilization is used only under emergency conditions.

Siphon Spillway in the O'Shaughnessy Dam

By G. F. STICKNEY
Consulting Engineer, Albany, N. Y.

The recently completed O'Shaughnessy Dam, in the Hetch Hetchy Valley, in California, forming a part of the new water supply system for the City and County of San Francisco, is the largest dam in which a siphon spillway is used and the spillway has a greater capacity than any other of this type, heretofore constructed. The dam is a concrete structure of gravity section, curved in plan, with a length on crest of 600 ft., and having a maximum height of 344 ft. above the foundation.

The reservoir, created by the dam, has an area of 2.5 square miles and

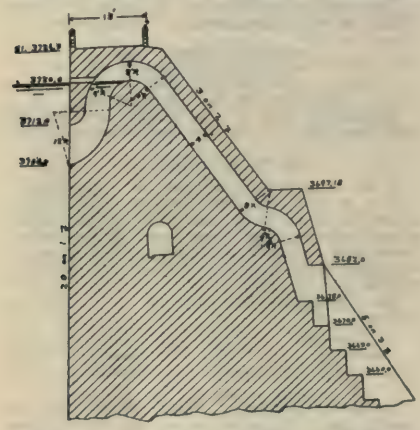


Fig. 1. Cross Section Through One of the Siphons.

a storage capacity of 206,000 acre feet. The drainage area, above the dam site, is 459 square miles.

Provision has been made for increasing the height of the dam 86 ft. whenever an additional storage of water becomes necessary. The reservoir filled during the latter part of May and the siphons then operated for the first time.

The spillway occupies a length of 250 ft. in the top of the dam and consists of 18 siphons—14 4 ft. high by 10 ft. wide and 4 4 ft. high by 9 ft. 2 in. wide—all operating under a head of 29 ft., with total capacity of about 20,000 cu. ft. per second. A cross-section, through one of the siphons, is shown in Fig. 1. The crests of the siphons are on three levels, with variation of 3 in. in elevations, and they are so arranged for the purpose of making the units prime at different water stages, thus varying the discharge of the spillway. There are two air vents, 12 in. x 24 in. in area, in the upstream wall of each siphon. These vents become submerged when the water level raises from 1 to 1.5 ft., sealing the siphon against the admission of air, and priming then quickly occurs. The siphonic flow having been established, the full discharge is maintained until the water level drops sufficient to expose the vents and admit a large volume of air and when this happens the flow ceases.

It may be noted that a raise of from 1 to 1.5 ft. in the water level, gives a discharge of 114 c.f.s. per foot width of siphon and that such a volume of flow, per lineal foot of weir, would require a depth over the crest of about 10 feet. Siphons of much larger size and capacity, than those in the O'Shaughnessy Dam, are entirely practicable and, where the full siphonic head is available, a discharge of more than 225 c.f.s. per lineal foot may be attained. The plans for the siphon spillway were prepared from studies and experiments made by the writer.

Cost of Icing Public Drinking Fountains

The city of Cambridge, Mass., maintains 9 public ice water fountains. The cost of furnishing the fountains with ice during the summer months for the past 18 years is given as follows in the 1922 report of Timothy W. Good, general superintendent of the Cambridge waterworks:

Year	Total Cost Per Year	Average Cost Per Day Per Fountain
1904	$460.35	$1.20
1905	514.18	.94
1906	795.64	1.57
1907	655.49	1.09
1908	705.99	1.04
1909	823.48	1.15
1910	712.65	1.24
1911	734.20	1.34
1912	918.75	1.25
1913	970.81	.97
1914	747.68	.78
1915	719.83	.74
1916	623.64	.79
1917	766.65	1.37
1918	1,216.04	1.57
1919	1,086.17	1.68
1920	1,062.69	1.82
1921	1,508.17	1.58

A Successful Shipment of Large Tanks by Inland Water Route

A novel shipment by water was recently made from the Old Hickory Powder Plant at Jacksonville, Tennessee, to St. Louis. Six tanks already erected at the Old Hickory Plant were purchased by the Monsanto Chemical Works for their Plant B in East St. Louis. As these tanks have a diameter of 20 ft. and a height of 12 ft., and weigh approximately 13 tons each, their size made it impractical to ship them by rail. It would first have been necessary to dismantle them and later reassemble them in their new location, incurring unnecessary expense. It was possible, however, to ship them by barge without dismantling them.

Six 20 Ft. Diameter Tanks Loaded for Shipment.

The tanks which were a part of the war-time equipment of the Old Hickory Powder Plant, rested upon a 20 ft. platform, and were lowered upon railway flat cars by means of two locomotive cranes. The flat cars were hauled to a concrete road which traverses the plant and the tanks were there transferred to low wagons, which were hauled down the concrete road to the river edge by caterpillar tractors. The distance from the original location of the tanks to the river is 1½ miles and was covered six times without mishap.

From the loading point the barge descended the Cumberland River through a series of locks to the Ohio, thence down the Ohio to the Mississippi, which it ascended to St. Louis, where the tanks were unloaded and installed in their new locations.

Upkeep of Fire Hydrant Systems

The increasing use of motor trucks is causing a noticeable addition to our work in the upkeep of the fire hydrant system, as many hydrants are broken by the operation of these vehicles in our streets. In most cases the department is able to obtain a setlement for the amount of the damages.

Other hydrants are put out of order by contractors and other inexperienced men using them without authority.

Our fire service system, covering about 1,200 hydrants, has been installed at large expense for protective purposes only and should not be used except by firemen in the discharge of their duties or by authorized waterworks employes. Our city ordinances prescribe penalties for unlawful use of fire hydrants and it may be necessary to bring offenders before the courts for punishment. Some contractors argue that because the city gives them water without charge in doing work for the city that they are entitled to get it by operating the fire hydrants. In every such contract made by the city it should be clearly stated, so that there can be no misunderstanding, that the fire hydrants must NOT be opened by contractors. —From 1922 Report of Frank E. Merrill, Water Commissioner of Somerville, Mass.

Annual Convention of American Society for Municipal Improvements.—This society will hold its next annual convention at Atlanta, Ga., Nov. 12-16, with headquarters at the Ansley Hotel.

Fine Screening at Activated Sludge Plant, Milwaukee

For the next twelve months the attention of sanitary engineers will be focussed on Milwaukee where the largest activated sludge sewage disposal plant in the world is now nearing completion. Under the direction of T. Chalkley Hatton, chief engineer, a group of buildings, aeration tanks and sedimentation tanks, covering an area of 30 acres on Jones Island, are now being constructed, after some six or eight years spent in preliminary studies and experiment.

The district served by the Milwaukee sewerage system includes, in addition to the city of Milwaukee, a number of nearby towns, the territory drained by the sewers comprising an area of 96,800 acres with a population of nearly 600,000 persons. The dry weather flow of sewage in this area is at present about 75 million gallons daily, but the plant is designed to treat 300 million gallons daily, this (it is estimated) being the volume of sewage that will have to be handled in 1950.

The sanitary sewage and trade wastes originating in Milwaukee County will be brought to the disposal plant on Jones Island through a comprehensive system of intercepting sewers terminating in four siphons (2 low and 2 high level), but under the harbor entrance 75 ft. below water level.

The raw sewage, after passing through bar screens to remove the large materials, flows through grit chambers where the mineral matter settles out. From the grit chambers the sewage passes through Tark Screens—a new type of fine screen developed by the Link-Belt Company—the effluent passing from the fine screens into an aerated conduit where it is mixed with 15 to 20 per cent by volume of activated sludge returned from the sedimentation tanks. The sewage and sludge, called "mixed liquor," is then distributed to the aeration tanks in the bottom of which are filtros plates through which air at 8 to 10 lbs. pressure is forced so as to produce a continuous stream of tiny bubbles.

After 6 hours' contact with air and returned sludge, about 95 per cent of the organic matter in the raw sewage is precipitated and a remarkable purification is effected. The "mixed liquor" finally passes into sedimentation tanks where, after approximately 30 minutes settling, the granular precipitate settles to the bottom and the purified effluent flows out at the top and is discharged into a conduit emptying into Lake Michigan.

In the brief time of 6 to 7 hours the raw sewage undergoes such purification that the liquor emptying into the lake is as clear and colorless as drinking water and will show an average reduction of 98 per cent bacteria and 97 per cent suspended matter.

To the sanitary engineer one of the most interesting features of the new Milwaukee sewage disposal plant is the battery of 8 Tark Screens which will be used for the fine screening of the influent. In practically all modern systems of sewage disposal fine screens play an important part and the Tark Screen is interesting as being one of the most recent developments in the art of screening municipal and industrial wastes.

As will be seen from the accompanying illustration each screen is a self-contained unit consisting of a rotating drum (carrying the screen plates), a number of revolving brushes which constantly sweep the surface of the screen (permitting the use of extremely fine apertures without danger of clogging), and motor and reducing gears mounted on a steel frame which extends across the influent channel above the drum.

The drum itself is installed in the influent channel across the line of sewage flow. The liquid portion of the sewage after flowing through the apertures in the screen plates passes through one end of the drum into the effluent channel, while the intercepted solids are swept from the outside surface of the drum into a sludge bucket, or mechanical conveyor, by the revolving brushes previously referred to.

At intervals in the drum, slots are left between the screen plates from which curved metal "fins" protrude. These "sludge-reclaiming plates," as they are called, serve to scoop up sediment from the bottom of the influent channel, as well as the scum that accumulates on the surface of the sewage, and carries all such debris up to the brushes which sweep it away. A cam mechanism automatically retracts the sludge reclaiming plates to a position within the drum as they aproach the brushes.

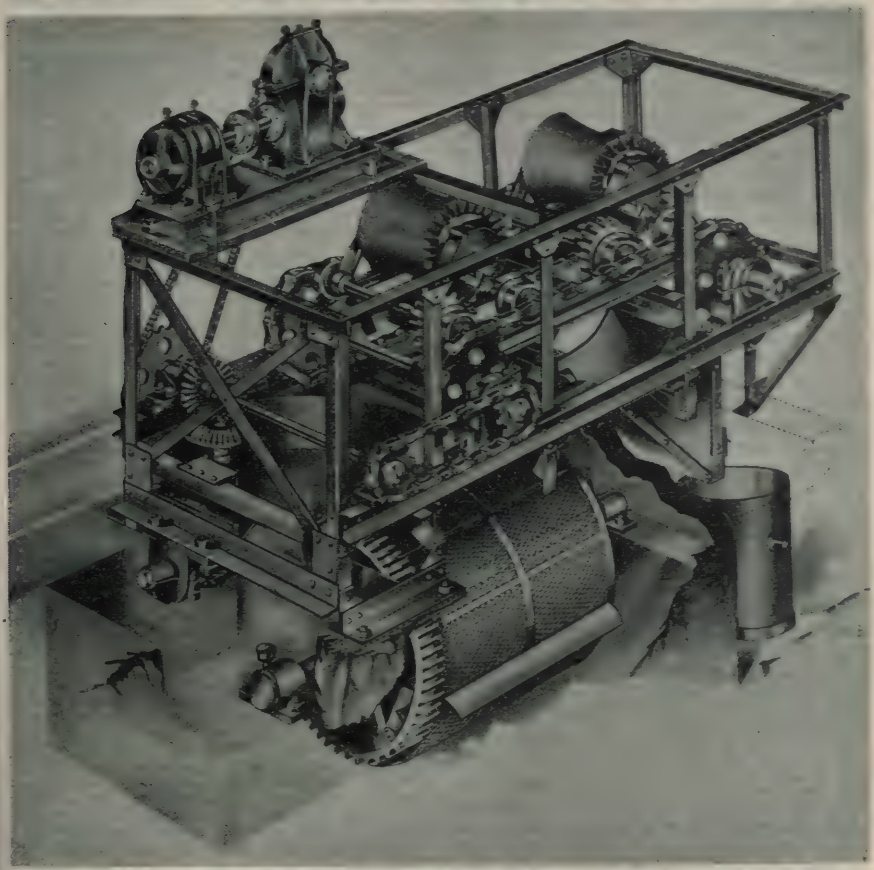
The drum is built up of small

each of which can be easily handled by one man, and all parts of the apparatus are in plain sight and easily accessible for inspection and adjustment.

The first two screens of the Tark type were installed in the sewage disposal plant of the little town of Pleasantville, N. J. (five miles from Atlantic City), in August, 1921, and it was the performance of these screens, and their freedom from trouble and repair, that led T. Chalkley Hatton, chief engineer of the Milwaukee Sewerage Commission, to adopt them after his return from a European trip during which he visited most of the largest and most modern sewage disposal plants of Europe.

The Tark sewage screen is made at the Nicetown, Philadelphia, plant of the Link-Belt Company.

Wages of Water Works Employees at St. Louis.—The average monthly wage paid employees in the supply and purifying section of the Water Works of St. Louis, Mo., has decreased from $120.76 in 1921 to $118.24 during the year ending April, 1923. The average wage is 168 per cent of the average wage during the year ending April 1, 1914. The number of employees averaged 229 for the year.



Tark Sewage Screen Similar to Those to Be Used in Milwaukee Activated Sludge Sewage Disposal Plant.

Increasing Life of Agitator Blades in Lime Mixing Tanks.—The life of the agitator blades in the lime mixing tanks at the St. Louis, Mo., filter plant was over 60 per cent during the past year, by using tool steel without annealing, for the purpose of drilling as was formerly done. The drilling is now done with a high speed straight fluted drill.

Blasting Frozen Ground in Excavating for Dam Foundation

Excavation for the foundation of Hubbart Dam, Flathead (Indian) project, Montana, disclosed rather unusual conditions, according to the June Reclamation Record. To reach bedrock for the left half of the dam it was necessary to remove from 8 to 85 ft. of overburden. This was in the form of a talus slope at the foot of an almost vertical cliff about 175 ft. high, and the material graded from rocks of several cubic yards each through coarse rock, fine rock, gravel and sand to a fine rock meal and clay. This mixture was solidly frozen and all interstices were filled with solid ice, so that the whole lower portion of the material to be excavated was in the solid mass or sheet from 6 to 12 ft. in thickness.

All efforts to dig this material with the 1¼-yd. steam shovels were futile, so shooting was resorted to. As attempts to drill into the mass were unsuccessful, bulldozing was tried with fair success, T. N. T. placed in shallow holes being used. By this means, successive thin layers of the material were broken up so that it could be removed by a scraper bucket. Unfrozen ground was finally reached, but not until 6 to 12 ft. of the ice-bound mass had been shot away over an area of about 50 to 140 ft. As many as 80 holes per shift were shot.

The encountering of ice and frost was no surprise, as test drifts and pits had indicated their presence, but it was not thought that the thickness would be so great nor that the frost and ice would extend below the water level of the creek as it did. Also it was expected that the mass would thaw out when exposed, but despite the fact that a considerable area was uncovered and exposed to the sun as early as Sept. 1, and that water from the shovel and supply lines ran over it, very little thawing took place, the clay, sand, and rock meal apparently constituting almost perfect insulation.

That ice keeps forming seems to be indicated by the fact that huge icicles have formed in the test drifts, and test holes sunk below the floor of the drift have filled with solid ice. In one drift, which had been fitted with a rough door so as to serve for a refrigerator for the camp mess, ice thawed but little even during July and August.

Industrial Notes

A. D. Parhm has opened a Chicago branch at 1515 Howard Ave. for the Westco-Chippewa Pump Co., operating factories in Chippewa Falls, Wis., Davenport, Ia., and Moline, Ill. The Westco-Chippewa Pump Co. formerly operated as the Western Pump Co., the name being changed about 8 months ago after the purchase 7 months ago of the Chippewa Pump Co., manufacturers of deep well heads.

The Four Wheel Drive Auto Co., Clintonville, Wis., has secured from the International Earth Boring Machine Co. (Chicago, Ill.) the exclusive rights to the sale of the International Earth Boring Machine. The boring machine will be sold as extra equipment and when attached to the FWD truck is especially adapted for digging pole holes for telephone systems, telegraph lines, electric car lines and municipal work.

Graver Corporation, East Chicago, Ind., manufacturers of water softeners, filters, tanks and general steel plate construction, announces the following changes in its district sales offices: The office formerly located at 2084 W. 29th St., Los Angeles, Calif., has been discontinued and the Water Works Supply Co., 536 Call Bldg., San Francisco, Calif., will represent the company in the entire state of California. The Seattle office, formerly located at 912 Post Bldg., has been discontinued and states of Washington and Oregon will be in charge of H. K. Mead, 409 Bd. of Trade Bldg., Portland, Ore. The Philadelphia office, formerly located at 528 Perry Bldg., has been discontinued and L. C. Holmes, 918 Buchanan St., N. W., Washington, D. C., will have charge of sales in this district.

New Trade Publications

The following trade publications of interest to water works men, engineers and contractors, have been issued recently:

Crane Excavator.—The Bay City Dredge Works, Bay City, Mich., has issued Bulletins Nos. 13 to 16, describing its convertible crane excavator, Model 16-B, with its various attachments, including a ¾-yard shovel type dipper, skimmer scoop for stripping or road and street excavation, clamshell bucket and ditcher scoop for sewer, trench, or ditch excavation.

Chains and Sprockets.—A 96 page catalog devoted entirely to chains and sprockets for drives, conveyors and elevators and other services has been published by the Webster Mfg. Co., Chicago. Illustrations and descriptions of the various types, together with specifications and price lists are included.

Multistage Series Pumps.—A new style of centrifugal pump, called a "series pump," is described in a catalog just issued by the De Laval Steam Turbine Co., Trenton, N. J. In this pump double suction impellers and volute diffusers are used, as in single stage centrifugal pumps. The connecting passages from stage to stage, however, are included in the pump case casting, as in the ordinary multistage pump.

Water Filters.—A bulletin describing the Graver horizontal pressure water filters has been issued by the Graver Corporation, East Chicago, Ind. It contains a description of the process together with specifications, useful tables and drawings of the various units.

Railways

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.
221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*
LEWIS S. LOUKE, *Vice-President and General Manager*
New York Office: 904 Longacre Bldg., 42d St. and Broadway
RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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(c) Harbor Structures
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Vol. LX. CHICAGO, ILL., SEPTEMBER 19, 1923 No. 3

Is It Practical to Improve the Calendar?

A year of 12 months is good, but months of 4 3/7 or 4 2/7 weeks are bad; while the month of February differs so much from the other 11 that it forms an added aggravation in spite of its simplicity of exactly 4 weeks. The inconvenience of being unable, without consulting a calendar or making a mathematical calculation, to tell on what day of the week the 11th of next month will fall may be a petty matter but it happens daily to all of us.

Changes in a system as firmly established and of as widespread use as our reckoning of time obviously are not easy; yet aside from customs and prejudices to be overcome, the difficulties are certainly far less than in changes from the old systems of weights and measures to the metric. Considering the success of the metric system in continental Europe and the large amount of attention that has been given to its development and promotion in this country, it is somewhat strange that so little has been heard of possible improvements in the calendar. Even precedent is not lacking, for there have been changes in times past, and our present calendar is but the latest of several that have done service. Another change to a substantially more convenient form would be warranted if it could be accomplished without too great expense and inconvenience. The editor believes that it can be so accomplished.

Suggestions for improved forms, and even attempted improvements, have varied. The French of the revolutionary period tried out a decimal system and failed. While a decimal arrangement has admitted attractiveness, the use of decimals in time measures has fewer advantages than in many other fields. Furthermore we must deal with a year of 365 days (366 on leap year), which at the outset makes any ideal decimal system impossible. The seven-day week may, we believe, be considered a fixture. Its antiquity, our habituation to it, and its religious importance to many

people would constitute most difficult, if not insuperable, obstacles to any change from it. Furthermore it is difficult to think in what manner the seven-day period could be bettered. It is comparatively seldom necessary to divide it into equal parts, and such divisions as are made are generally of the working week of 6 days so that both halves and thirds came out with complete convenience.

The suggestion has been made more than once that the seven-day week be retained, and the year divided into 13 months of 28 days each, with the 365th day as a holiday—probably New Year's—not included in any month or any week. In this way every month would begin on the first day of the week, and each succeeding day of the month would have its unvarying week day. The thirteenth month would be given a name of its own and probably placed at the end of the year.

Months all of exactly equal length, all exactly divisible by either weeks or days into halves and quarters, and an unvarying relation between day of week and day of month certainly possess an advantage that the year would no longer be divisible by months into halves, quarters and thirds, is small by comparison with the gains. The occasions for such divisions of the year are comparatively rare but even divisions of the month meet us at every turn.

The segregation of the 365th day outside of any month or week would cause practically no more inconvenience than is already caused by every important holiday. The interruption of the sequence of 7 day cycles on the first day of each year is scarcely likely to arouse serious objection on religious grounds from many persons, even among the strictest Sabbath observers; and its treatment as a holiday already partly religious in character and which might be observed wholly as a religious holiday by those who chose, would go still further to remove this objection. "Leap Year Day," when it occurs, would be similarly converted into a holiday detached from any week or month and introduced probably at the middle of the year.

Change to such a system would involve negligible inconvenience and expense. Contracts and other documents calling for payments or performances on specific dates in future years would be covered by law so that the total number of days to their maturity would be the same under the new system as under the old, and no difficulty or confusion whatever result. In general the 30 and the 31-day month would merely have passed into and become a part of history. There would be none of the expense of changing measures and the inconvenience of dealing with machines and commodities made under the old system that has proved so serious an obstacle to the introduction of the metric.

The project should be fairly easy of accomplishment in the United States, and the greatest difficulty might easily be the securing of sufficient international co-operation to warrant the undertaking. On the other hand it ought to be possible to enlist the support of the most important and progressive of the European nations in such a movement of mutual benefit. We hope to see the effort made and carried to success.

Buses and Electric Railways

Editorial in The Canadian Engineer.

Following the phenomenal development of jitney bus traffic there has been a disposition in many cities of America for buses to enter into competition with street railways. The unpopularity of street railway managements in some of these cities has brought about a favorable public attitude to this competition. It was thought that the street railways would be brought to time by the competition and that the result would be a much improved service and an improvement in the attitude of the railway to the city.

Where such competition has been permitted on streets accommodating electric railways, the result has been anything but that expected. Competitive jitney operations was one of the causes which lead to the collapse of street railway service in Seattle and compelled the city to take over and operate the system in 1920. Thereafter jitney licenses were refused if they would compete with the municipal railway system. In Toledo jitneys were formerly allowed to compete with the street railway but the effect on the railway revenues and service was so adverse that their op-

eration was prohibited in a downtown district of about 50 blocks. In Providence, competition with the street railway service has been prohibited and regulations greatly reducing the competition in the city of Richmond, Va., have been put into effect. In some cases street railway operation was suspended altogether for a time, as in Des Moines, Ia., but whether the service has been wholly suspended or greatly reduced, the outcome has been the same, namely, that it is impracticable to permit unrestricted competition of buses with a street railway and expect to have adequate street railway service. The legitimate field of the bus in transport in large cities is an auxiliary to the street railway and any policy which goes beyond this, is a vicious one.

A Big Construction Program for the Railways

Editorial in the Railway Age.

In spite of the fact that the railways are now in the midst of the most active construction program which they have undertaken during the last ten years, more work has been authorized during the last few weeks than in any similar period for a long time. Among these projects, that of the Illinois Central for the construction of a new line from Edgewood, Ill., south 175 miles to Fulton, Ky., involving an expenditure of more than $17,000,000 is the most important. Immediately following the approval by the Interstate Commerce Commission of its application for authority to build this line, officers of the road announced that work on this improvement would start at once. About the same time Julius Kruttschnitt, chairman of the board of the Southern Pacific, stated that in view of the announced decision of the government not to appeal the decision leaving control of the Central Pacific in the hands of the Southern Pacific, that road would proceed at once to build the Natron cut-off of 118 miles in eastern Oregon which will cost more than $16,000,000. With the Union Pacific's extension from Rogerson, Idaho, south 98 miles to Wells, Nev., which was authorized by the Interstate Commerce Commission recently, work on nearly 400 miles of new lines will be started promptly.

The authorization of these new lines is indicative of the large amount of improvement work of other character which is also being undertaken. The Chicago, Milwaukee & St. Paul has awarded contracts within the last month for the construction of 36 miles of second track in Illinois and Indiana, and the Louisville & Nashville has contracted for the building of 55 miles of second track which is estimated to cost $3,500,000. The Kansas City Southern has authorized the reduction of grades costing more than $3,000,000; the Chicago Union Station Company has awarded a contract for the building of a headhouse at a cost of more than $10,000,000; bids are now being received for the driving of the Moffat tunnel under the continental divide in Colorado, which is approximately six miles long and is estimated to cost more than $6,000,000; the Atchison, Topeka & Santa Fe has started the construction of a ten-story general office building at Topeka, Kan., while the Union Pacific has authorized the expenditure of $3,000,000 this year for preliminary work in the development of an industrial district at Kansas City, Kan.

With the demand for increased facilities evidenced by the continuation of a record-breaking traffic and with the improvement in earnings resulting from this traffic, the roads are showing evidences of a willingness to expand their facilities which characterized their activities prior to 15 years ago. Since the reason is so far advanced that most of the projects now being authorized must, of necessity, be continued over into 1924, indications point to the continuance of construction activities through next year.

Railway Operating Results.—Class I railroads of the United States, according to reports from 193 roads representing a total mileage of 235,670 miles, in July earned an annual rate of return of 4.93 per cent on their tentative valuation as fixed by the Interstate Commerce Commission for rate making purposes, including additions and betterments up to Jan. 1. 1923. This rate represented a net operating income for the month of $84,591,400.

Current Material Prices

Iron and Steel Prices

(From the Iron Age, Sept. 6, 1923)

Prices as of Sept. 4, f. o. b. Pittsburgh:

Open hearth rails, heavy, per gross, ton	$43.00
Light rails (25-45 lb. section), per 100 lb.	2.25
Track spikes, 9/16 in. and larger base, per 100 lb.	3.15
Track spikes, ½ in., 7/16 in. and ⅜ in., 100 lb.	$3.25 to 3.75
Track spikes, 5/16 in.	$3.25 to 3.50
Spikes, boat and barge, base, per 100 lb.	$3.50 to 3.75
Track bolts, ¾ in. and larger, base, per 100 lb.	4.75 to 5.50
Track bolts, ½ in. and ⅝ in., base, per 100 lb.	$4.15 to 4.50
Tie plates, per 100 lb.	2.55 to 2.60
Angle bars, base, per lb.	2.75

Finished Iron and Steel

	Per lb. to large buyers. Cents
Iron bars, Philadelphia	2.67
Iron bars, Chicago	2.40
Steel bars, Pittsburgh	2.40
Steel bars, Chicago	2.50
Steel bars, New York	2.74
Tank plates, Pittsburgh	2.50
Tank plates, Chicago	2.60
Tank plates, New York	2.84
Beams, Pittsburgh	2.50
Beams, Chicago	2.60
Beams, New York	2.84
Steel hoops, Pittsburgh	3.15

Freight Rates

All rail freight rates from Pittsburgh on domestic shipments of finished iron and steel products, in carload lots, to points named, per 100 lb., are as follows:

Philadelphia	$0.32
Baltimore	0.31
New York	0.34
Boston	0.365
Buffalo	0.265
Cleveland	0.215
Cleveland, Youngstown, comb.	0.19
Detroit	0.29
Cincinnati	0.29
Indianapolis	0.31
Chicago	0.34
St. Louis	0.43
Kansas City	0.735
Kansas City (pipe)	0.705
St. Paul	0.60
Omaha	0.735
Omaha (pipe)	0.705
Denver	1.27
Denver (pipe)	1.215
Pacific Coast	1.34
Pacific Coast, ship plates	1.20
Birmingham	0.58
Memphis	0.56
Jacksonville, all rail	0.70
Jacksonville, rail and water	0.415
New Orleans	0.67

Rails and Track Supplies at Chicago

Standard Bessemer and open-hearth rails, $43; light rails, rolled steel, 2.25c, f. o. b. makers' mills.

Standard railroad spikes, 3.25c mill; track bolts with square nuts, 4.25c mill; iron tie plates, 2.85c mill; steel tie plates, 2.60c, f. o. b. mill; angle bars, 2.75c, f. o. b. mill.

Jobbers quote standard spikes out of warehouse at 3.90c base and track bolts, 4.90c base.

Cement Prices

Recent quotations, per bbl., in carload lots, exclusive of package:

Pittsburgh	$2.24
Cincinnati	2.54
Detroit	2.50
Chicago	2.20
Milwaukee	2.37
Duluth	2.25
Minneapolis	2.50
Davenport, Ia.	2.43

Cross Tie and Lumber Prices

(From Lumber, Sept. 7, 1923)

White Oak Ties

F. o. b. cars, Chicago, Sept. 5.

No. 5—7x9x8	$1.85
No. 4—7x8x8	1.75
No. 3—6x8x8	1.55
No. 2—6x7x8	1.45
No. 1—6x6x8	1.35

Red oak ties, 10@15c less than white oak. Sap pine and sap cypress, 10c less than red oak.

White oak switch-ties, per M. ft.	$55 to $58
Red Oak switch-ties, per M. ft.	49 to 51

White Oak Ties

F. o. b. cars, St. Louis, Aug. 1.

No. 5—7x9x8	$1.60
No. 4—7x8x8	1.47
No. 3—6x8x8	1.30
No. 2—6x7x8	1.20
No. 1—6x6x8	1.10

Red oak ties, 10c per tie less than white oak prices. Heart pine and heart cypress, same prices as red oak. Sap pine and sap cypress, 25c less than white oak.

White oak switch ties, per M. ft.	$48.00
Red oak switch ties, per M. ft.	45.00

Bridge and crossing plank, same prices as switch ties.

Market Prices of Lumber

	Flooring, 1x4, No. 1 common	2x4, 16 ft., No. 1 common	Timbers, 6x6	Timbers, 12x12
Boston—Yel. Pine	.....	.....	$55@57.00	$63.00@66.00
New York—Yel. Pine	$57.00	$45.75	50@52.00	57.50@63.00
Buffalo—Yel. Pine	53.00	.....	.....	47.50@51.50
Chicago—Yel. Pine	45.00	.....	.....	51.00
St. Louis—Yel. Pine	43.00	.....	.....	41.50@42.50
Seattle, Wash.—D. Fir	56.00	20.50	28.00	25.00

Southern Mill Prices

	Flooring, 1x4, No. 1 flat	2x4, 16 ft., No. 1	Timbers, No. 1, 4x4 to 8x8	Timbers, No. 1, 3x12 to 12x12
Alexandria—So. Pine	$38.00	$26.00	.....	.....
Birmingham—So. Pine	38.78	.....	.....	.....
Hattiesburg—So. Pine	39.73	26.71	$28.50	.....
Kansas City—So. Pine	.....	25.72	28.84	39.87

Methods and Cost of Cleaning Ballast

Abstract in Railway Engineering and Maintenance of Committee Report Presented Aug. 11 Before Metropolitan Track Supervisors' Club, New York City

Among the requirements of stone ballast, which is the ballast in general use under heavy traffic, is that it must be clean in order to perform its necessary function of drainage. Dirty ballat produces rough track on account of pumping in summer and heaving in the winter. To obtain clean ballast it is necessary to screen out the dirt. This is almost universally done by means of hand labor with ballast forks. On account of the enormous expense of this work and the inability to keep up with it under present labor conditions, considerable study has been given to the development of machinery which will not only cut the cost of screening, but will permit an output sufficient to produce clean ballast at a reasonable cost.

Cleaning Railway Ballast by Means of Ditchers and Clam Shell Buckets.

The development of such a machine is not at all impossible. The chief obstacle to its achievement is the apparent endeavor to produce a machine at a low cost, by which we mean several thousand dollars. It is thought that an expenditure of $50,000 to $100,000 would result in a machine which would do the work and save enough money to justify the investment.

What the Ideal Ballast Cleaner Should do.—The ballast cleaner should do the following:

(1) Thoroughly clean stone.
(2) Load screened dirt in cars.
(3) Require a minimum of hand labor (no shoveling).
(4) Deposit clean stone where desired.
(5) Clean tie cribs.
(6) Obstruct no more than one track when in use.
(7) Show a very large saving over hand labor.
(8) Cover a large yardage daily.

Such a machine, we understand, is now being worked on by different people.

Probably the first effort to get away from the forking of ballast by hand consisted of a screen onto which the ballast was thrown by hand, to separate the stone from the dirt. This was improved some years ago and the result was the Trench-Zepp ballast screen.

This screen has done some very good work on a number of railroads. The screen is set at an angle and held by supports in the rear, the dirt going through the wire mesh and the stone falling at the foot of the screen. Provision is made for lowering the screen to clear passing trains and with this feature some roads used the screens in the inter-track space, dropping them when trains passed on either side.

The Trench-Zepp machine was tried by many roads and used extensively by the Baltimore & Ohio, but in actual use it showed very little merit over the ordinary hand method of cleaning other than saving stone, which, figuring a 10 per cent loss,

amounts to 79 cents per rail length, resulting in a net cost of $2.31 per rail length to clean ballast by this method.

The Pratt mechanical ballast cleaner was an effort to make a machine that would work in the center ditch continuously, without interference with passing trains, and do the work mechanically. And endless chain, carrying three small buckets, was driven by a one-cylinder gasoline engine. The dirty ballast was lifted by these buckets and thrown on a shaking screen. The dirt went through the screen onto a pan, where it was shoveled out by hand. The stone passed over the screen to the inter-track space.

On account of the close clearance the buckets could not be turned from side to side, but had to be kept directly in the center, between the tracks. This meant that, in order to cover the entire ditch, one man had to help the dirty ballast into the buckets. The machine traveled forward on a caterpillar tractor, propelled by one man working a lever in the rear. This forward movement was later attached to the engine, but without success, as it was found that the speed forward had to be changed as the material, with which the machine worked, varied. This machine would average six rail lengths per day with five men under favorable conditions. The repairs, however, were heavy on account of the severe duty required of such a comparatively light machine, which, including stone saved, showed a net cost of $2.34 per rail length.

Cleaning by Ditcher and Clam Shell Buckets.—The cleaning of ballast with a ditcher and clam shell is being done by several railroads. The dirty ballast is lifted out of the center ditch with a clam shell and dropped on a movable screen which is mounted on a gondola car. The dirt goes through the screen and the stone is directed through a steel chute back into the inter-track space. The clam shell varies from ¾-yd. to 1 yd., depending upon the width of the space between tracks and to about 1 ft. below the bottom of the ties. At the same time it breaks up the area between tracks to a depth considerably below this. The screen is made of ¼-in. rods with a 1½-in. mesh, and is set at a slope of about 45 deg. It is 9 ft. wide on top and tapers to about 2 ft. at the bottom.

Although this machine will not do as thorough work as can be done by hand, it will cover ground much more rapidly and is helping to meet the present labor shortage by relieving track gangs of much important work. Usually two ditchers are operated in one train, each working with a screen on a gondola car, although as many as three ditchers have been worked as one train unit. With a two-ditcher train the average day's work has been found to be about 55 rail lengths of center ditch. The cost of this work, for a 9-hour day, is as follows:

Engine crew	$ 16.45
Train crew	17.96
Laborers (4)	12.60
Foreman	5.27
Ditcher engineers (2)	9.31
Ditcher firemen (2)	6.54
Train expenses (9 hr. @ $6.50)	58.50
Ditcher expenses	20.00
Total	$146.63

Operation of the Harris-Muff Machine.—The Harris-Muff power ballast cleaner consists of a moving belt in a trough, into which the dirty ballast is shoveled. This ballast is carried to a circular screen which separates the dirt from stone. The stone is sent through a chute to the track, either center or between tracks, and the dirt is carried on a moving belt and deposited clear of the ballast shoulder. The entire mechanism is operated by a gasoline engine, which also serves to propel the ballast cleaner at a rate of about 15 miles per hour when going to or from work or clearing trains. Skids are also provided, which enable the machine to be set off the track in about eight minutes.

The customary operation is to skeletonize the track in advance of the machine. This can be done while the machine is clearing for trains so that no time is lost on that account. The ballast that has been taken out of the cribs and the stone in the inter-track space are shoveled into the machine where it is screened and returned to the track.

The proper number of men to work this machine is about 15 and the cost will run about $2.50 per rail length. Including the ballast saved, this figure is reduced to $1.71 per rail length. This figure is based on 16 rail lengths

of track cleaned in a 9-hour day and is arrived at as follows:

15 Laborers (9 hr. each) @	$3.60	$54.00
1 Foreman	5.00	5.00
6 gal. Gasoline	.23	1.38
¼ qt. oil	.23	.06
1 lb. grease	.15	.15
Total cost to clean 16 rail lengths		$60.59
Cost per rail length		$ 3.75

This does not include the cost to skeletonize the track, but includes one 6-ft. space and one shoulder. As, for purposes of comparison, we desire to consider the cost to clean the 6-ft. space alone, and as two-thirds of the operating force is used to shovel stone from the 6-ft. space into the machine, we take two-thirds of $3.75, or $2.50, as the cost to clean a 6-ft. width per rail length. The stone saved per rail length (10 per cent) is valued at 79 cts. This brings the cost to clean the 6-ft. strip per rail length to $1.71.

Harris-Muff Power Ballast Machine.

As the dirty ballast is shoveled onto the moving belt by men directly opposite each other, attention is called to the wooden guard placed directly over the belt, which requires all stone to fall on the belt and prevents it from reaching the men on the opposite side of the track. This machine could be improved by extending the receiving belt to clear the body of the machine, which would permit the belt to be lowered so that the men would not have to lift the ballast so high. This would increase production. Some mechanical means for feeding the machine should be devised to eliminate hand labor. The capacity of the machine is far in excess of what hand labor can keep up with.

Some interest has been shown lately in the possibility of cleaning ballast by vacuum suction, and plans for such a machine have been drawn up. Such a machine could lift dirt and stone with a separating process. There are no doubt possibilities along this line if the necessary money can be secured.

It is thought that the cleaning of cribs can be done cheaply, and as quickly, by hand forking as by first skeletonizing track and then rehandling stone to pass it through a machine, for the reason that, with the usual hand method, a few cribs are first cleaned out in advance and as ballast is forked out of the dirty cribs it is shaken, and clean stone thrown directly into the empty cribs with one handling. In skeletonizing the track and then passing dirty ballast through a machine, two handlings are necessary. With present machine methods we therefore eliminate the cleaning of cribs except by hand and show below the cost per rail length to clean a 6-ft. width by the various methods in use at the present time; with tracks at 13-ft. centers:

Method	Depth Below Ties	Cost per Rail Length
Trench-Zepp	6 in.	$2.31
Pratt	3 in.	2.34
Clam Shell (two ditchers in one train)	12 in.	1.86
Power Ballast Cleaner	6 in.	1.71
Hand	6 in.	3.10

For purposes of comparison the different depths attained in the 6-ft. areas have been disregarded, but the results obtained, for obvious reasons, favor the method reaching the greatest depth.

The committee concluded that the power ballast cleaner is the most economical of the present known methods, with the clam shells and gondola screens second in cost. The chief objection to the power ballast cleaner, as compared with the clam shell and screen, is that the former will not cover enough ground per day to keep up with the amount of cleaning necessary to make clean track. The committee, therefore, recommended the use of the power ballast cleaner where its production can meet requirements, and the use of the clam shell where

the amount of dirty track is excessive and large production is necessary.

The committee emphasized, however, that none of the machines described answer the requirements fully and reiterated the belief that a proper machine can and will be developed when a sufficient expenditure is made.

Results of Test on Erie Railroad.—As an appendix the committee presented a report of the performance of a power ballast cleaner on the Erie Railroad at Elmira, N. Y. As the figures for this report include the cost of a skeletonizing gang it cannot be compared with the figures already quoted, except in a general way. It, however, is interesting as showing the savings effected by the use of this machine.

In an 8-hour day the fuel consumption approximated 10 gal. of gasoline and 2 qts. of oil. The stone to be cleaned was first cribbed from the track to the shoulder by a force of men well in advance of the machine, and then shoveled into a long trough through which a belt operates carrying the stone to the revolving screen. The cleaned stone was returned to the track at any point desired by means of a metal chute at the rear of the machine which can be shifted so as to place the stone either between the rails or outside the rail to the end of the ties. The dirt was delivered onto a moving belt, which placed it on the shoulder at the 7-ft. line.

The force required for efficient operation of the machine depended on local conditions. At Elmira the organization after several changes was as follows:

1 foreman.
10 men cribbing out in advance of the machine.
7 men placing the stone in the machine; 3 on the outside shoulder and 4 in the space between tracks.
1 man disposing of the dirt at the 7-ft. line.
1 assistant foreman in charge of the machine and operating the stone chute.
1 machine operator.
1 flagman.

This organization was able to clean an average of 96 ft. of track per hour. At the location where the machine was used the traffic is quite dense, an average of 95 trains being operated over the two tracks in 24 hours. The machine was delayed by passing trains 22 per cent of the total time it was in use. The average cost per lineal foot of track cleaned was 15 cts., the average cost per cubic yard of stone cleaned being 42 cts. This effected a saving in favor of the machine of about $700 per mile of track and an approximate saving of 25 per cent in stone, as there was no waste of stone in cleaning by this method.

When there are sufficient men, the work should be arranged so that the tie renewals are made while track is open, since by doing this a considerable saving can be effected in the cost of renewals. At Elmira the ties were renewed after the ballast had been cleaned, at which time the track was given a 2-in. raise, surfaced, lined and dressed and had the appearance of newly stone ballasted track. The work was carried on under W. J. Flynn, supervisor of track, with N. Manberg, section foreman, in direct charge.

Concrete Railway Ties in India

The North Western Railway of India has made exhaustive tests of a new type of concrete railway tie patented by a Delhi Consulting Engineer. Experiments have been made on 50 mi. of main track near Delhi and the results have been so satisfactory that a further 70 mi. of track will be similarly equipped as soon as the necessary ties are manufactured, says a report to the U. S. Department of Commerce from Vice Consul Robert F. Kelley at Calcutta. The tie consists of two concrete blocks joined together by a tie bar, the rails being fastened by means of a screw or dog spike driven into wood plugs, specially treated and compressed, set in the bed of the concrete block. The other Indian railways are interested in concrete ties. The East Indian Railway has been using a large number of Green-Moore patent reinforced concrete ties for seven years and has now nearly completed factory for manufacturing 500,000 railway ties per annum. The Green-Moore tie is the invention of the Deputy Chief Engineer of the East Indian Railway and is similar in construction to the type in use on the North Western Railway. They have been favorably reported on by the Senior Government Inspector of Railways since 1915-1916, who states that they are still in perfect condition and show no signs of weakness. The Bengal Nagpur Railway has decided to adopt the Green-Moore tie and has acquired a license to manufacture 300,000.

The Outlook for the Street Railways

The Future for the Industry Outlined in a Paper Presented at Recent Meeting of Missouri Public Utilities Association

By F. G. BUFFE,
General Manager for the Receivers, Kansas City Railways Co., Kansas City, Mo.

Several days ago in a discussion of utility problems and prospects, in connection with reorganizations and consolidations that have been recently offering their securities to the public, I was asked what, in my opinion, was the outlook for the street railways. Coming from a man whose business lies largely with the financing of utilities, the question naturally meant what was the outlook for the street railways from the investor's standpoint.

The answer was that any service as necessary and essential to our centers of population as street railway transportation, must of necessity have a future, and that this future must include some assurance of an earning power to those whose money made the service possible. Furthermore, any industry that had stood the punishment and survived the blows of the last five years, could only have done so because of this very element of necessity.

The Size of the Industry.—There is today invested in street railway properties over $5,000,000, or almost one-third of the total investment in the entire public utility industry. It has 44,000 miles of track, employs 300,000 people, and has a gross revenue of approximately $500,000,000.

Two hundred and twenty-five companies, comprising 50 per cent of the total in the country, and 43 per cent of all interurbans, report to the American Electric Railway Association. These companies in 1922 had railway operating revenues of $464,365,210. They gave over 1,000,000,000 mi. of service and carried a total of 7,806,-296,180 passengers. The net income of these companies increased from $22,852,418 in 1921 to $37,237,680 in 1922, an increase of 63 per cent.

It is estimated that at the present time between $200,00,000 and $250,-000,000 of new money is required yearly if extensions now needed are built and necessary public betterments made.

Surely an industry of this nature, absolutely vital to the social and civic well-being of millions of people, must not only have a future, but this future must be such as to make possible its absolutely essential growth.

Railways a Necessity.—The essential nature of the street railway business is now admitted by all students of the question, even including those radicals who at one time were predicting its relegation in favor of bus or other trackless methods of transportation. While it is admitted that in some places and under certain conditions a limited field for bus transportation may be found, it can only be as a feeder or subsidiary, and that neither the economics nor the physical limitations in the situation will permit their substitution for street railways.

It is generally conceded that rubber tires and gasoline cannot and will not compete in mass transportation methods with electric power and steel rails, or that a vehicle limited both as to carrying capacity and to life can take the place of a unit capable of handling large numbers of people with a minimum of life at least four or five times greater than the bus.

The two big single steps forward in the last five years, and for both of which the industry has been forced to pay dearly in loss of interest and depreciated securities, have been, first, the changed attitude on the part of the public as indexed by newspapers and the decisions of courts and commissions; and, second, the advanced methods of operation to which we have all been driven in our efforts to prevent total submergence in the sea of financial depression.

Fares and Expenses.—The fixed fare has gone, never to return. It was an economic mistake in the beginning, and was the sort of handcuff upon progress which no business could endure and survive.

The average fare today for the 275 cities in the United States of over 25,000 population, is 7.27 cts., and there has been only a reduction of a small fraction of a cent from the peak of car fares.

Until there is some radical change in conditions affecting expenses, there can be but few and small reductions in prevailing fares. Since the pre-war period there has been an increase of over 100 per cent in wages, and such small reductions as were effected a year ago are being made up today by increases and the demand for increases, many of which must doubtless be met either voluntarily or through arbitration. Material prices, which showed some decrease last year as against the peak in 1920, have in the past six months taken a sharp rise, until today materials and supplies are from 10 to 20 per cent higher than they were in the fall of 1922.

Coal prices are fixed for the next year at a level very little if any under that of a year ago. Therefore if there is to be no radical change this year in the price of labor, coal and materials, which represent from 80 to 90 per cent of operation expense, there can be little hope of any change in the fare situation.

The general statement can be made that expenses are today practically 100 per cent greater than in 1915, whereas the average level of fares is approximately 45 per cent.

Advanced Methods of Operation.—Operating methods have without question improved in the past few years. One-man operation has become established, only seeing its beginning. In Kansas City approximately 23 per cent of all car hours operated are one-man hours, and we are making changes in our equipment that will permit an increase in this percentage. We have hopes of at least operating 50 per cent of our service in this way, using the reconstructed one-man, two-men cars. The public has in large measure become sold to the one-man theory of operation and its installation is no longer looked upon adversely or with unnecessary criticism or comment.

Improved Relations Between Company, Employes and Public.—Perhaps one of the most effective advances in operating methods has been the changed relations existing between management, employes and the public. The idea of merchandising our transportation product or selling it against competition of both private automobiles and jitneys, and the possibility of giving the public a better and finer car service for the increased fare has been sold to employes in all branches of service.

We have at last to some extent made our men realize that they are selling representatives and that their wages come through the fare box from our passengers. This has been reflected in a changed feeling between employes and passengers, and the desire on the part of the former to give more service, better service, and a more courteous service, and of a recognition by the latter that their fares, although higher, were buying them more than ever before.

There has been a changed spirit between men and management. In the first place better wages and a higher standard of living have attracted a superior class of platform men to the service. They have realized that they must work hand in hand with their officers if they were to insure the continuity of their employment and if they were to maintain the high wage standard that had been set by increased living costs.

Street railways will never again offer a speculative method of making money. If there was ever any water in their securities, it has been dried out long since by war conditions and by the efforts on the part of the public and public authority to hold fare increases to the minimum. In return, however, the realization of their absolute necessity on the part of the public will in the future insure at least a fair interest return upon the capital actually and honestly invested.

This feeling has been reflected in commission decisions as well as in the courts, and returns of 7 and 8 per cent are now permitted in many states.

An Obstacle That Must Be Overcome.—One of the great obstacles that still remains to be overcome and which is being vigorously taken up by the American Electric Railway Association and other allied interests, is the subject of taxation, both direct and indirect, but more especially indirect taxes. Such taxes are an outgrowth of old taxing methods when it was the theory on the part of public authority to get every dollar out of their utilities possible.

There was little or no regulation as to earning ability, very little competion from other modes of transportation, and from a taxation standpoint, all that the traffic would bear was the prevailing idea. As a result, street

railway companies in practically every city are carrying paving requirements; viaduct obligations; street cleaning taxes; car license taxes; park taxes; and all sorts and conditions of taxes, in addition to the general state, county and city taxes which have been yearly increasing.

In some places where the theory of service-at-cost has been definitely established, and where the public and public authorities realize that such methods of taxation are placed upon the shoulders of those least able to bear them, namely, the car riders, these indirect taxes have been removed.

The Competition of Motor Vehicles.—The most serious inroad, of course, upon the earning power and the ability to serve of the street railway companies in the past decade has been the tremendous increase in the use of private automobiles. Some recent figures on this in Kansas City, Mo., alone, are but indicative of the situation throughout the country. In 1914 there were not to exceed 8,000 private cars in the city limits, not counting Kansas City, Kan. Their use was to a large extent restricted to pleasure purposes, or they were owned by those who formerly owned and used carriages. Therefore their total effect upon the street railway ride habit was negligible. The latest figures in Kansas City, Mo., show a registration of 53,500 private cars, and from an occasional pleasure use they have become an every day affair. In 1917 the Kansas City Railways carried 137,000,000 people, whereas in 1922, which for us was a good year in every respect, we carried 136,000,000, despite an increase in population of at least 35,000.

However, it would seem that a limit has been reached in our large American cities to the use of the private automobile for every-day ordinary business purposes. This limit is not economic, is not due to the price of gasoline or to any habit of thrift on the part of those owning cars, but purely due to the physical limitations of the cities. Either the use of automobiles will have to be restricted or our congested districts will have to be rebuilt. Conditions are rapidly approaching the point where there is no longer room in the streets and at street intersections for a further increase in vehicular traffiic. Parking ordinances and traffic regulations are daily becoming stricter, and are having an increasing tendency to reduce the use of machines.

A Summary of the Street Railway Situation.—Perhaps the present and future situation for the street railway may be summarized somewhat as follows:

A service-at-cost fare is here to stay.

There has been a change in the relations between management and employes and the public for the betterment of all concerned.

Public authority, reflecting public opinion, realizes the necessity of the street railway for mass transportation.

Relief from indirect taxes will be secured.

The use of the private automobile is limiting itself to some degree and street railways may expect to get back some proportion of the increase due to population.

Speculative returns are gone, but a fair interest return on capital actually invested will be not only permitted but encouraged.

Operating methods have advanced and will continue to advance on the side of economy, particularly in the use of the one-man car.

The street railway is an economic necessity and as such its future to some extent will be guaranteed.

The above is a rather hasty, horseback review of the present day situation. There is one feature, however, that seems so apparent as to be almost unnecessary to mention. This is the fact that the public will and does expect a higher grade of service for the higher fare than ever before and that it is willing to pay for it. The cornerstone of our whole structure from now on is service, coupled with the fact that those who avail themselves of this service must pay its cost, and that this cost will include and must include a reasonable return upon the dollars of those investors who have made this service possible.

Engineers for U. S. Bureau of Standards.—The U. S. Civil Service Commission, Washington, D. C., will hold an open competitive examination on Dec. 5 for junior engineer, junior physicist and junior technologist to fill vacancies in the U. S. Bureau of Standards. Entrance salaries range from $1,200 to $1,500 plus $20 per month.

Concrete Slab Highway Grade Crossings

General Features, Construction Details and Suggestions on Installing Given in Concrete Highway Magazine

Grade crossings have always been a source of anxiety and trouble for railroad and highway officials, not only because of the ever present danger of accidents but even more because of the difficulty of maintaining the crossings in good condition. The growth of highway traffic and the increasing use of heavy motor trucks in the last decade have greatly aggravated the situation. Smooth, easily maintained crossings are daily becoming more necessary. Crossings that seemed excellent to the traffic carried by the dirt roads of ten years ago are woefully rough and unpleasant to the automobile traffic on the concrete roads of today.

Railway roadbeds at crossings do double duty. They must support heavy, high speed trains at least as well as adjacent tracks—rough spots shake up passengers, wrack equipment and are a source of danger, whether in crossings or other places, In addition, at crossings railway roadbeds must support heavy automobile traffic, lighter than rail traffic, it is true, but far more frequent and, because of the flangeways, causing heavy impact. This double load rests on the ties, which distribute it through the ballast to the subgrade. Unless the subgrade is firm, the ballast is pounded into it and the crossing soon becomes rough and uneven for both railway and highway traffic.

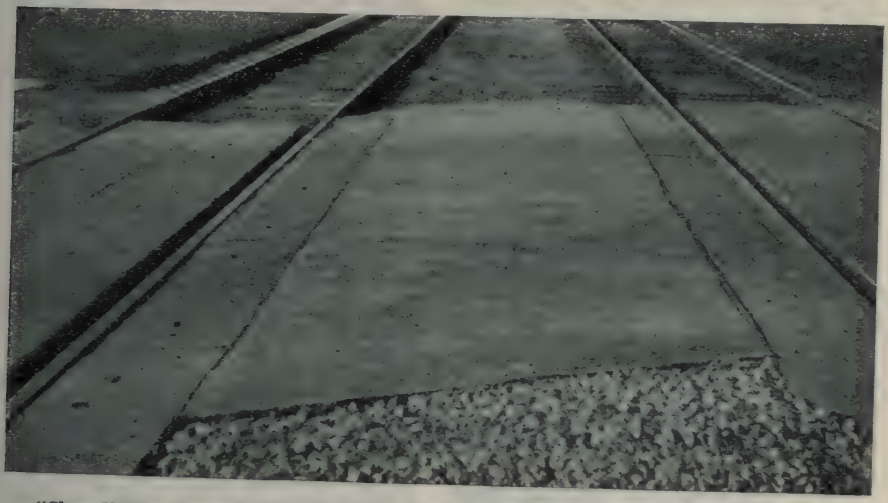
Good drainage is the first essential. Surface and ground water must be carried away quickly before it can soften the subgrade. Sun and wind will help dry ordinary track, but at crossings the crossing surface, whether of wood planks, macadam or concrete slabs, prevents their action.

Even with good drainage the crossing must usually be taken up at least once a year to permit tamping the ties. Wooden crossing plank, fastened to the ties by spikes or lag screws, are apt to be damaged when they are taken up, or to be broken by heavy trucks. Consequently their life is short. Some crossings require repairs as often as once a month.

Concrete Slab Crossing Installation on Chicago, Burlington & Quincy R. R.

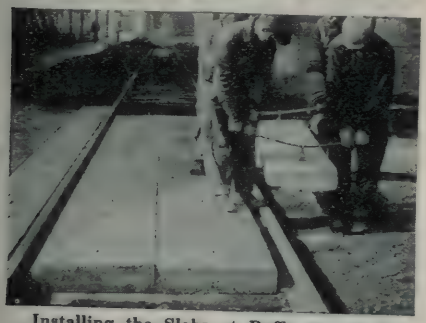
Concrete crossing slabs eliminate many of these difficulties. They are precast in exact widths that will fit the gauge without the necessity of alteration or adjustment in the field. By the use of lifting sockets cast in the slabs at the time of manufacture it is the work of but a few minutes to remove the entire crossing. There

are no spikes to pull and no planks to split. When the slabs are removed the track can be tamped, ties renewed if necessary, nuts tightened and the track put in general good condition. A few minutes more and the slabs are replaced. No trimming or spiking is required.



"Close Up" of Concrete Slab Crossing on Illinois Central R. R. at North Riverside, Ill.

Construction Details.—Concrete in highway grade crossing slabs should be of the highest quality, for the service required of it is severe. Care should be taken to secure good materials and thorough mixing. Too much mixing water should be avoided.



Installing the Slabs at Buffington, Ind.

Metal forms are to be preferred and will be found cheaper in the long run. Experience has shown that it is wise to protect the edges of the slabs by armor plate or curb bars. These shapes and the lifting sockets should be securely fastened to the forms to prevent displacement during the placing of the concrete.

The concrete should be placed in the forms in layers, and each layer thoroughly tamped to avoid the formation of honeycomb spots. Finishing may best be done with a wooden float which will work the mortar to the top, but which will not produce a surface that is too smooth.

As with all concrete work, curing is important. The slabs should be kept wet for at least the first 10 days and better for 20 days. They should not be placed in the track until they are at least a month old.

Completed Crossing in Wayne County, Mich.

Suggestions on Installing.—Before the slabs are installed, the track should, of course, be put in good condition. Sawed ties only should be used and they should be accurately spaced so that all joints between slabs

will be supported. The tie should be well tamped to an even bearing. The surface of the ballast should be at least 2 in. below the top of the ties in order to avoid heaving action due to frost.

Some roads use lag screws through the holes in the lifting sockets to fasten the slabs to the ties—others think this unnecessary. In some cases small wooden wedges are driven into the joints to keep the slabs tight.

There are several methods of providing flangeways. If a metal guard is used care must be exercised to prevent short-circuitng the signals. Asphalt, felt or wooden strips have sometimes been used for insulation.

The Motor Bus and the Electric Railway

Abstract of a Paper Read at the August Meeting of the Wisconsin Utilities Association

By JAMES W. WELSH,
Executive Secretary, American Electric Railway Association

The motor bus is proving itself today to be a very useful ally to the electric railway industry. It has been taken up by many companies to develop extensions into districts not previously served and in some cases to replace non-profitable routes when expensive track and paving replacements became necessary.

Owing to its low capital investment it has saved electric railway companies from making the large expenditures ultimately required for a permanent rail system. The latter is deferred until traffic is developed to the point where the lower operating costs of the rail installation is sufficient to justify its larger capital requirement.

The question of fitting the bus to transportation service is, however, a detail to be worked out in accordance with local requirements. It is vastly more important that communities should recognize the necessity of coordinating their transportation service as a whole, from the standpoint of public convenience, safety, comfort and economy.

It is disastrous to the public as well as to the private interests concerned to encourage or permit the competition of unregulated buses with the closely circumscribed service and fares of the electric railway. To be fair, both must come under the same authority, and be subject to the same restrictions. The alternative is to remove all restraints from both and let the electric railway run the service it pleases at any fare it sees fit to ask.

State Regulation of Motor Buses.—Every state in the Union has taken official action with respect to the motor bus, except six. Public Utility Commissions have some sort of jurisdiction in 32 states and in 17 of these the commission has issued general orders governing their operation. Thirty-six states have imposed a gasoline tax. The certificate of convenience and necessity under which competition with electric railways or other buses is either completely eliminated or restricted is effective in 20 states. Unfortunately, however, in some of these states this requirement is of recent origin and does not apply to buses previously in service. Issuance of indemnity bonds is required in 23 states and reporting of accidents in 15.

The Commission has authority over rates of fare in 19 states and regulations regarding routes are prescribed by the commission in 14 and schedules in 16. It is the larger and more important states that have taken the lead in these matters and consequently it may be said that the country as a whole has progressed well in according the bus a legitimate place in transportation.

The Question of Bus Fare.—When it comes to the question of fare to be charged, it is even more important that the community as a whole should be considered. Every electric railway man knows that the cost per passenger carried varies through the widest possible limits on the various routes of any system of any size. He would gladly agree to carry passengers for a 5 ct. fare if he could choose certain routes only on which this would apply. Other routes of the same system less favored by density of traffic, length of haul, and other factors, would require fares ranging from 10 cts. to a dollar or more. If the greatest good to the greatest number is to be the principle, then the fare should be averaged within the limits of the areas where a common interest is recognized.

Thus it is that the bus when allowed to compete unrestrictedly with the established rail service has been able to choose a favorble route and seemingly operate successfully at a

low fare. In the city of New York today, the operators of buses on the Grand Concourse are finding they are losing money on the 5 ct. fare prescribed by the city administration.

Uregulated competition may, therefore, be counted as only a passing phase in the application of the motor vehicle.

Effect of Motor Vehicles on Passenger Traffic.—A more vital question, I believe, is the ultimate effect of the motor vehicle, including all its forms, on the riding habit. If the riding habit is increasing, then the transportation industry is stable and may look to the future with confidence.

What has been the effect of the 11,000,00 pleasure automobiles on the number of riders on public conveyances such as the electric railway and the legitimately operated motor bus. To determine this we have prepared an index number representd by the daily car riders averaged for the month and going back for several years. There are, of course, numerous factors which affect this figure, such as general business conditions, employment, etc., which are reflected in this study.

The index is based on the average of 1920, as this represented the best year since the war. It is noted that the trend is downward to the winter of 1921-22, since when it has been climbing upward and now has gone above the 1920 average. As this includes no bus passengers, and represents 80 typical railways picked at random over the country it is a most significant and encouraging sign of the inherent stability of the electric railway.

This represents a total of over 15,000,000,000 passengers for the country and an annual gross revenue of $1,100,000,000, of which $50,000,000 is from the carrying of freight. This gives the electric railway seventh place among the industries in the value of its output. There are 45,000 mi. of railway track today in active service and the total capital invested is $5,600,000,000. These are large figures and are significant of the magnitude of the industry.

Electric Railways and Taxes.—As a tax collector, the electric railway has been quite successful. It contributes today $92,000,000 annually in the form of direct taxes plus the other imposts levied upon it such as paving, street cleaning, snow removal, etc. These charges amount to 10 per cent of fares collected on the average while in individual cases they amount to as much as 15 per cent.

In other words, from ½ ct. to 1 ct. out of every street car fare is collected as taxes. This is the culmination of a burden which has been increasing at an alarming rate in recent years. For the year 1922, the direct taxes alone amounted to $70,000,000 and with the other imposts to $92,000,000, while the net income was but $84,000,000. Thus the electric railways paid more money into the public treasury last year than they paid to their stockholders and to the various reserve funds combined.

Since 1890, operating revenues increased 1,000 per cent while taxes increased over 2,000 per cent, and net income increased a little over 500 per cent.

Improved Conditions of Railways.—Comparing the first half of 1923 with 1922, the Association's returns from companies throughout the country are most favorable.

There has been a 6.6 per cent increase in passengers carried; a 3.5 per cent increase in gross revenue; a 6 per cent increase in net revenue and a 3.7 per cent increase in service measured by car miles operated.

This has been accomplished in spite of a 2.5 per cent increase in wages paid; a 3.6 per cent reduction in average fare per passenger.

In other words the industry as a whole has increased wages and decreased fares. It has increased the services rendered, and carried more passengers. At the same time it has increased its net revenues, or the company's own share of the receipts. If this doesn't indicate a promising condition and a wide-awake and efficiently conducted business, I will leave it to the professional investigators.

Evidences of good management and an active and searching study for improvement in the industry are many. Labor-saving machinery in track construction has permitted track to be relaid under traffic conditions at a minimum cost.

The welded rail joint is saving millions while it offers a smooth riding surface, which is the despair of the jitney. The Association has raised a fund of $23,000 to study this further.

The automatic substation is a saver in power costs. Lightweight one-man cars have been important in aiding

service in certain places while still larger cars with trailer operation are providing a rapid and comfortable ride in others. Shop practice and maintenance methods have lowered upkeep costs.

These are a few of the improvements. Many others are under way. In all this the electric railway has not had the benefit of as many competing manufacturers striving to serve it as has the motor vehicle, but has had to solve its problems with comparatively very much limited resources. The use of higher priced materials and the release of inventive and mechanical genius will undoubtedly add greatly to the further development of the industry.

Summary.—The motor vehicle is a new tool in the hands of the railways offering a cheap method of expansion as a forerunner to the installation of the permanent rail system. It has taught the riding habit to those who used to walk and increased the opportunities for transportation service.

Nothing has developed or is likely to which will destroy the necessity for public transportation.

Regulation by public authorities are overcoming the inequities of the past and unjust competition is being eliminated.

Taxation and the additional burdens due to franchise obligations are receiving close study and the future should see a material alleviation in this direction.

Wonderful opportunities for inventive genius exist in improving the mechanical forms and economies of transportation facilities and with these should come corresponding return to the industry.

Record Car Loadings.—During the week ending Aug. 26 a total of 1,069,932 cars were loaded with revenue freight. This exceeded by 28,888 cars the previous record, which was established during the week which ended on July 28 this year, when 1,041,044 cars were loaded. This also exceeded by 51,393 cars the record of 1,018,539 cars established in the fall of 1920, and which stood until this year.

Liquid Oxygen Explosives

A liquid oxygen explosive as made today consists of a permeable organic container, filled with the absorbent material, which is soaked in liquid oxygen immediately before use, states C. A. Taylor and W. H. Rinkenbach, assistant explosive chemists of the U. S. Department of the Interior, in Bulletin 219, recently issued by the Bureau of Mines. This cartridge is inserted in the borehole and exploded either by an electric detonator or by a special safety fuse and cap.

An inactive absorbing material, such as kieselguhr or aluminum oxide, is sometimes added. The proportions of the various ingredients of the cartridge should be such that they will absorb sufficient or more than sufficient liquid oxygen to completely oxidize the combustible matter present. Kieselguhr is unaffected, but is supposed to assist in the propagation of the explosion wave.

The cartridge is usually a tube of paper toweling, which serves as an insulator cloth and as a combustible. A permeable envelope of a material such as cheese cloth is so constructed that it will fit into the insulator. This envelope holds the absorbent and combustible materials and also serves as a combustible. The material within the envelope may be classified as (1) absorptive and (2) combustible.

The absorbents that do not take part in the chemical action are usually kieselguhr (diatomaceous earth) and aluminum oxide, although the latter has not been used much. The combustibles sometimes serve also as absorbents, as was originally intended. Wood pulp, cotton, lampblack, coal dust, wood charcoal, and cork charcoal serve a double purpose, whereas crude oil, paraffin, other liquid hydrocarbons, and naphthalene are combustibles only.

Fillers for Cartridges for Liquid Oxygen Explosives.—An investigation of fillers for cartridges of liquid oxygen explosives is being made by the Department of the Interior at the Pittsburgh experiment station of the Bureau of Mines. The work includes a study of the physical and chemical properties of fillers, the absorption of oxygen and the retention of oxygen and finally their effect as ingredients of the explosive mixture.

Important Features of Modern Locomotive Terminals

Committee Report* Presented June 21 at the Annual Meeting of the American Railway Association

The following is a summary of the data gathered in 1922 by the American Railroad Association committee on Design and Operation of Engine Terminals, plus a certain amount of information published by the American Railway Engineering Association on this subject.

General Layout of Terminal.—Terminals are all more or less of a compromise. There are so many circumscribed elements affecting each point that no matter whether the terminal is built by gradual expansion or is constructed new, the final arrangement will generally reveal some undesirable features. A good labor market will often overbalance the selection of a site which would have been of greater strategic value.

The site selected should be such that soil water will not drain into the house or turntable pit. Enough land should be acquired to allow for 100 per cent expansion in the future. Many variable factors enter into the best selection of a site; proximity of transportation yards, cost and availability of land, distance from passenger station, necessity for smoke abatement, street car or other transportation, etc.

Studies along broad lines should be made before a terminal layout best suited to meet present conditions and future demands can be adopted. Investigation will frequently reveal the fact that a reduction in delay at modernized terminals will be equivalent to adding power to the division. The typical engine terminal is considered as a division clearing house and it is assumed that it literally controls the amount of freight and passenger-service that can be furnished by the transportation department.

Summarizing, engine terminals must be laid out so that one operation will not interfere with another. The importance of this cannot be over-emphasized. If one operation depends upon another for its success, unless that one is a success, the other will be a failure. Each facility should be independent to an extent that if any one unit or operation should fail it would not have the effect of stopping or retarding the operation of the terminal. Few operations can be conducted efficiently for any length of time if the facilities are strained to the limit. To this end each facility should be designed to perform double the work ordinarily required and at important terminals duplicate facilities should be provided. A single track lead to an engine house is inexcusable. With three or more tracks available a majority should be assigned to incoming engines. Sufficient leads, switches, and crossovers must be provided to avoid delays at coaling station, ash pit, inspection pit, or other facility. As a general rule a number of short leads are preferable to a single long load as this enables one engine to move independently of others. Where number of leads is restricted frequent crossover switches should be provided to prevent blocking any locomotive. Lead track to turntable should line up with corresponding tracks in engine house for convenience in placing dead engines in the house.

Enginehouse Design—General Features.—Modern enginehouses divide themselves into three classes; a brick wall with wood frame and roof, reinforced concrete frame and roof, and a combination of steel frame and reinforced concrete. The first mentioned type is cheapest and most generally used, but the trend has been toward reinforced concrete. All enginehouses should be of fire-proof construction as far as possible. In designing an enginehouse provision should be made for doubling the capacity needed. It is first necessary to determine the class of repairs to be made and the extent of such repairs. This involves a study of the capacity for doing such work at other terminals to which the engines run. Also the proximity of a back shop largely determines the extent of repairs necessary in the enginehouse. It is desirable to locate the house some distance from a city in order to get cheaper land, but in leaving the city care should be taken from an adequate labor market. The number of stalls to be provided is a function of the engines to be handled and the expected detention. If 100 engines are to be cared for and each may

*From the Railway Age.

occupy a pit 12 hours, then 50 pits will be needed. If the average detention is only 8 hours a day then 34 stalls will be ample. Quality of water, as affecting boilers, and amount of local switching may also exert considerable influence upon the number of stalls necessary.

Enginehouses are made in various cross sections to suit local conditions, facilities, funds and taste. The modern house for a large terminal may have an overhead crane with down draft system, boiler washing plant, drop pits for driving, engine truck and tender wheels, jib cranes at frequent intervals and many other up-to-date facilities. Practically all of the later designed enginehouses have increased head room to improve ventilation and lighting. The continuous monitor type of house, single or double, is now being more generally adopted. The depth of the house, over all length of section, has now increased to 132 ft. on several large roads. The rear walls of the house (outer circle walls) should be practically all windows if good lighting is desired. Window sills should be about four feet from the floor.

Shape of House.—In some localities the shape of the property makes a rectangular house fit better than a round house. For large stations a transfer table may be located between two transverse rectangular enginehouses and some rectangular layouts will require both a transfer table and a turntable. A transverse rectangular house is preferable to a longitudinal arrangement. The rectangular house, owing to its parallel spacing of pits, is much easier and cheaper to build than a round house. One particular advantage of the rectangular house with a wye is the saving in space permitted inside the building on account of the parallel track arrangement. Also the building may be designed so that it may be increased by adding multiples as desired. Leads and wye tracks cost less to maintain than turntables. The vulnerability of the turntable to accident is pointed out as a reason for the wye arrangement.

Enginehouses should be designed so that both engine and tender trucks can be removed at the same time, with tender cut loose, if desired. The distance from the engine pilot to the outer wall varies from 8 to 15 ft. and from tender to inside doors, 5 to 10 ft.; distance from engine to side walls from 5 to 10 ft. Doors vary from 12 to 14 ft. wide and from 14 to 18 ft. high. Doors are made of wood or steel frame, swinging, and rolling wood or steel slats. Columns may be omitted in the drop pit section and trusses substituted. This provides a clear passage for moving wheels from pits to rear of house. Outer row of columns should be made strong enough to support jib cranes, which may then be installed at any time desired.

In January, 1921, a committee of the American Railway Engineering Association collaborating with a committee of the Mechanical Division, American Railway Association sent out a questionnaire covering the principal features of enginehouse design. Here follows a short quotation from the 1922 report of this committee.

Floors and Doors.—The Mechanical Division committee recommends a permanent floor, preferably wood block or brick on a concrete foundation for the outer half of the house where most trucking is done. Concrete is satisfactory for the remainder of the floor. The floor should slope from the line of columns between pits to drain into pits, about ⅛ in. per ft. The committee considers the ideal floor to be of creosoted wood block (12 lb. per cu. ft.), laid direct on a 6-in. concrete base with a bituminous cushion and filler. Such a floor is easy to truck over and work on and does not damage engine parts and tools dropped on it. The floor will be waterproof. Floor between pits can be made cheaper than in the outside circle where most trucking is done. The roof structure recommended is to be fireproof and is a combination of reinforced concrete and tile. Non-fireproof roof to be wood of slow burning construction.

Replies to the questionnaire indicated a marked preference for swinging wood doors. Rolling lift doors are not as satisfactory on account of the liability of getting out of order and the difficulty in repairing damage done by engines. The committee recommends the wood swinging door as satisfactory and easy to keep in repair. Door openings should not be less than 17 ft. in clear height and 13 ft. in clear width. The replies to questionnaire developed the general opinion that there is no satisfactory smoke jack. Cast iron is the first choice, asbestos second, and wood third. Wood, fireproofed appears to be as satisfactory as any other type. The smoke jack hood recommended is 42 to 48 in. wide and at least 10 ft. and preferably 12 ft. long with a flue opening of at least

7 sq. ft. All piping, etc., should as far as possible be maintained outside the path an engine would take in passing through the outer wall of the house, account of accident.

Turntable, Tractor and Pit.—Turntables are now generally 100 to 110 ft. long and 120 ft. is being used for Mallet engines. All turntables should be equipped with a suitable tractor or tractors. A Mechanical Division Committee of the American Railway Association at a meeting December 15, 1920, concluded that one turntable was ordinarily sufficient for a 50-stall enginehouse. A 50-stall house would provide for dispatching 100 engines per day if, for example, each engine was detained in the house (average) 12 hours a day. This would mean 200 moves of the table daily if each dispatchment required two moves, one in and one out, and all engines were dispatched. In other words, the table must turn once every 7.2 minutes. If a peak load period occurs in which 25 per cent of the movements are made in four hours this would require the table to turn once in every 4.8 minutes, which is about as fast as dependable operation will justify. Another consideration is the delay on account of failure of power or table which in some cases may justify one table for enginehouses with less than 50 stalls.

The size of the turntable has a considerable bearing upon the number of stalls in the house and longer tables permit more approaches without having frogs in the track at edge of table. Generally, the longer the table the less waste floor space at outer circle of house, this results from reducing the angle of stalls. The turntable deck should be wide enough to provide a walk each side with handrail protection. The turntable pit should be paved and drained. The turntable should be long enough to balance the engine when tender is empty. A deck turntable with plate girders below in pit is preferable to a through plate type with shallow pit, when the cost of construction is not greater and when drainage will permit.

There are two recognized types of turntables:

1. Balanced.
2. Three point support.
   (a) continuous—through beams.
   (b) non-continuous—bolted or riveted beams.

The minimum length of balanced turntable should be such that no part of the engine or tender will project beyond the edge of the table when the engine with tender empty is balanced on the table. With an adequate three-point support table no part of the engine or tender will ever project beyond the ends of the table as the balancing feature is not necessary with this type.

Cranes, Tractors and Hoists.—Where heavy repairs are contemplated, an enginehouse may be equipped with overhead cranes. When the house is not equipped with a down draft exhaust system, the crane may only extend from the smoke jack to the tender but with the down draft system the crane may be extended to the outer circle wall of the house. This emphasizes one particular advantage resulting from down draft methods. Portable cranes are always useful and should be generally employed. Jib cranes are recommended, even when an overhead crane is provided, if quick material movement is desired. Without an overhead crane, jib cranes of two- or three-ton capacity, swinging on outer circle columns between working pits, are very desirable. Jib cranes at drop pits are best located on the nearest column to the pits. Tractors, where floors are suitable and specially provided, will greatly expedite the movement of material. Many commonly removed parts of modern engines have now outgrown the hand operated truck.

A joint committee of the American Railway Engineering Association and American Railway Association made a report in 1922 in part as follows: "Replies received from forty-two roads regarding cranes showed that twenty-one roads used no mechanical devices at all, seven used traveling cranes, eight used some jib cranes, eight used monorails and chain hoists and five used tractors. Six roads contemplated using traveling cranes. In general, the crane equipment is dependent upon the nature of repairs to be made, proximity of back shop, etc. A terminal handling 75 or more locomotives per day should have overhead cranes or be well supplied with jib cranes. The general feeling regarding the use of unwheeling hoists in engine houses seems to be that they will prove economical where all drivers are to be dropped and work done on them, but where no work is to be done on the wheels or on a few pairs only, the drop pits are more economical. The same remarks apply to the drop table

in this case as to the unwheeling hoists."

Engine Pits and Drop Pits.—A Mechanical Division committee of the American Railway Association concluded that the following characteristics of engine pits were desirable.

Distance from inner face of outer wall of engine house to inner face of pit wall	13 ft.
Distance inner circle columns to pit wall	10 ft.
Clear width of pit	4 ft.
Clear depth of pit below top of rail	2½ ft.

Jack timbers should run the full length of the pit. Pits should be crowned at the center with a gutter on each side. Drainage should be toward the turntable with a sewer grate at the extreme end of the pit. The slope for drainage should be at least 6 in. total.

The majority of roads recommend drop pits to take care of main trailer, engine truck and tender truck wheels. Pits for the engine wheels are especially desirable. Installation of pits for removing tender wheels would raise the standard of maintenance. Where Mallet engines are handled a double drop pit is recommended. Drop tables are favorably mentioned for enginehouses. A hydraulic jack is favored for drop pit work although several roads prefer air jacks since the telescoping feature requires less depth of it. There is reference to a special compressed air telescoping jack which gives reliable service. Drop pits should be located near the machine shop so that wheels can easily run in, if desired. Drop pits or drop tables are necesary in every house and the installation of a hoist does not do away with need for a drop pit when a pair of wheels must be removed.

Shops and Tool Equipments.—The extent of the shop facilities will depend upon the location of the house with reference to the back shop. The machine shop should be in an annex, or adjacent to the enginehouse and generally contain only such machinery as is necessary for light or running repairs. It is not good practice to install machinery in the circle or enginehouse proper. The boiler, smith and tin shops may be located in the machine shop for small terminals, or adjacent to it for larger houses.

The following machines and facilities have been recommended by previous committees for enginehouses operating independently of back shops:

1—36-in. by 36-in. by 8 ft. planer
1—36-in. drill press
1—30-in. radial drill press
1—20-in. drill press
1—44-in. boring mill
1—lathe for largest piston head
1—24-in. by 16-ft. engine lathe
1—16-in. by 6-ft. portable lathe
2—16-in. by 6 ft. stationary lathe
1—28-in. D. H. crank shaper
2—double grinders
1—grindstone
1—50-ton press
1—4-inch pipe threader
1—1½-in. bolt cutter
1—double punch and sear—24-in. by 36-in. metal up to 1½-in. thick
1—flanging clamp, 10-ft.
1—800-lb. steam hammer
1—set tin shop tools
2—1 man electric welders
1—acetylene torch outfit
Blacksmith forges and an annealing furnace.

It is well to located the machine shop as far away as practicable from enginehouse gases. The American Railway Engineering Association typical terminal layout shows the machine shop extending out from the circle of the house with one enginehouse track passing through it. The blacksmith shop, foreman's office and toolroom, also storeroom, are shown in the machine shop or adjacent to it. Another alternative plan shows the engine and drop pits in the machine shop and two enginehouse tracks entering the machine shop but not passing through it. The boiler and smith shops are in the machine shop with the office and storehouse building adjacent. The boiler, tin and pipe, flue and smith shops in large terminals are best located in separate rooms or buildings adjacent to the machine shops.

Boiler Washing System.—The majority of roads questioned by the committee favored equipping all enginehouse stalls with hot water wash-out and refilling facilities. A few roads prefer only one-half of the enginehouse so equipped. The general opinion is that washing boilers with hot water is at all times desirable from the standpoint of saving in time, fuel and water and reduction in fire box and flue repairs. When a house is not equipped with a washing system the blow-off steam from boilers should discharge outside the house. All hot water and steam pipes should be lagged.

A committee of the American Railway Engineering Association considered it good practice to place a set of blow-off boxes not far from the cinder pit so that locomotive boilers may be

blown off a little before entering the enginehouse. This arrangement reduces the chances of clogging the blow-off line in the enginehouse, and where boiler washing plants are installed gives cleaner water for washing out and less sediment to dispose of.

Plans have recently been advanced which aim to fill boilers with steam at 100 lb. pressure or over, steam to be obtained direct from power house. It is claimed that this procedure results in much saving of time and is more economical than present practices. Your committee recommend that this matter be investigated further and report made.

Ash Handling Facilities.—There is some difference of opinion as to the best location for ash handling facilities. It is generally conceded, particularly in cold climates that ash pits should bé located near the enginehouse so that engines can readily enter the house, on their own steam, with fires dumped. Also the time of exposure of firebox sheets to the cold is shortened by this location. The ash pit is unquestionably the governing facility outside of the enginehouse. This is due to the length of time required for this operation. New ash pits should be designed to take care of a peak load of 25 per cent more engines than the ordinary maximum and 50 per cent more would be better.

The kind and type of ash handling facility depends entirely upon local conditions. The length and capacity of pits depends upon the maximum number of engines handled at the terminal in 24 hours. At terminals where a large number of engines must be handled quickly probably the water pit type is the best. At terminals where there is no congestion of engines the bucket conveyor type of ash pit works out satisfactorily. Water pits do not function as well in cold weather account of steam rising from the water and tendency for loaded wet ashes to freeze solid in cars. In designing water pits, care should be taken to safeguard all approaches so that men will not fall into them. A well-designed water pit will allow from four to six engines to be handled at one time and the pit capacity should be sufficient to hold ashes for several days, if necessary, account of damages to crane or lack of car supply. Water pits require a minimum number of men for the service rendered and the force may be easily adjusted to the demand. The capacity of pits may be increased readily by lengthening at either end. Length of each pit handling two engines per track should be from 1½ to 1¾ times the length of engine and tender, and length of pit handling 3 engines per track should be from 2½ to 2¾ times length of engine and tender. The type of engine selected should reflect future operating needs.

A new type of ash pit having many unusual features has been described recently in technical publications. This pit is located in the roundhouse and runs transversely under each stall. Engines come direct from train to stalls in house. The pit is a sloping trough 14 ft. wide at top in which a stream of water flows constantly. Ashes dropped into this trough are washed down to an outside storage pit from which they are loaded into cars with clam shell buckets. The top of the trough is level with the bottom of engine pit and when not in use is covered with a movable plate to preserve the continuity of the engine pit floor. Your committee suggests that this arrangement be investigated and reported on by a future committee.

Ash pit design obviously depends upon the number of engines handled. A check of over 7,000 fire cleanings showed 1.41 cu. yd. of ashes removed per engine, with a good grade of coal. Your committee recommends from 2 to 3 cu. yd. of ashes per engine for average storage capacity. Where local data has not been secured it is recommended to design pit capacity on basis of engine standing 45 miles on pit for cleaning operation. This includes two men working 30 minutes.

Coaling Station, Sand Storage and Water Cranes.—Coaling stations may be of the modern mechanical type or the older gravity tipple. The type selected usually depends upon the number of engines handled, the number of tracks available for coaling engines and the kind of coal used. Station capacity should be at least 24 hours' supply and better 48 hours, for maximum demand. The coal storage bins should be made self-cleaning as much as possible by proper sloping of forces. Gravity tipple outlet fixtures may be of the under-cut or over-cut type. Preference is shown for the over-cut fixture as it seems to provide more even mixing of coal delivered.

Mechanical coaling stations should be of the transverse type and a station serving several tracks is preferable to

the longitudinal type because it facilitates engine movement to and from the station. When it is necessary to deliver coal to two or more tracks it is best to install a mechanical type of station. Loaded coal car tracks should have a down grade toward the track hopper to permit easy feeding of cars. The receiving hopper must be long and wide enough to handle a complete car and provide sufficient room for unloading and handling coal. The hopper should be protected from the weather. It is not good practice to have a steel car chute to close to ash pits on account of fumes from wet ashes corroding the steel. A good many modern mechanical stations are built of concrete, with usual bucket type conveyor. Under certain conditions a belt conveyor has been found satisfactory and economical. A coal measuring or weighing device is recommended for all coaling stations.

A longitudinal coaling station designed recently and described in technical papers shows coal dumped into a pit below the ground level. A clam shell with traveling crane lifts the coal to gravity chutes which deliver direct to dealers. This type of coaling station has a number of new features which may prove superior in operation or economy to other types. Your committee suggests that this arrangement be studied and reported on by a future committee.

Sanding facilities are usually found in common with coal chute so that sanding may be accomplished while taking coal. Also in small terminals the duties of men operating tipple and sand facilities may be combined. Sand should be dumped from road cars into a pit beneath the track or trestle. Storage capacity of green sand should be sufficient for several months' supply; a winter's supply should be provided in cold climates. Modern sanding facilities are recommended for all large terminals. One well-known arrangement provides for dumping wet sand through a hopper to an underground storage pit, from there it is elevated in conveyor buckets to dryers which in turn discharge dry sand by gravity into tanks. These tanks are charged with air which forces dry sand to other tanks high enough to discharge by gravity to engine boxes. Smaller terminals may be equipped with dryers preferably of the stove type, on ground level which discharge dry sifted sand by gravity into underground tanks from which sand is forced by air to overhead gravity tanks similar to mechanical arrangement just described.

The location and number of water cranes or columns depends upon the importance of the terminal and local conditions in the terminal and yard. Water supply for yard engines should be especially considered and water storage tanks should always be of very liberal proportions. No water crane should be located where the overflow will freeze on switches. Suitable sewer gratings should always be furnished to carry away surplus water. Water columns should also be located near the entrance to the terminal and water should be equally available for inbound and outbound engines. Engines taking water should not block the movement of other engines.

Inspection Pits and Washing Platform.—A number of roads have found inspection pits to be an important addition to the terminal. In cold climates pits should be covered with a protection shed. Pits should be connected by transverse tunnels with steps up to ground level in the clear. The inspector's office should have a pneumatic tube connection with enginehouse foreman's office to expedite writing up and issuing orders for making repairs necessary. Track space for two times their capacity should be allowed front and rear for power waiting for and leaving the inspection pits. Inspection pits are best made of concrete with floor crowned in the middle for drainage. Sufficient sockets for portable and fixed lights should be provided. The inspection pit is really the entrance or beginning of the terminal. Here the crews are usually released and it is a convenient location for locker, wash and toilet rooms for crews, also the inspector's office.

Buildings and Offices.—The location of the wash platform is subject to considerable difference of opinion. In some cases it is thought best to wash engines first on entering the terminal and before inspection. Others prefer to wash last, after engines leave ash pits and just before entering house. Some roads, particularly in cold climates, prefer the washing facilities in the enginehouse and one stall is occupied for this purpose. The wash platform should be arranged so that oper-

ators can climb up easily when washing upper parts of engines and tenders.

The officer in charge of enginehouse should have an office adjacent to the house. This building should provide rooms for usual clerks and dispatchers. Suitable locker and wash rooms and toilets should be provided for all engine house employees, also an ample supply of drinking water conveniently located. A proper telephone connection for all offices at the terminal is very important. This may be handled through a private branch exchange.

The supply house should be so located that supplies may be taken from incoming engines, checked into house and out again to out-going engines. The location depends upon the general design of the terminal and should be so convenient as to cause no delay to arriving and departing engines. At small terminals the supply house, if large enough, may be used jointly with other houses or offices which may be located nearby.

Light repair sheds are not in general use. A considerable number of engines do not have to go into the house and these may be very readily cared for in the repair shed. Shed should be located near the machine shop. Light repair sheds provide cheap floor space for tightening and testing engines and thus conserve the high-priced floor space in the enginehouse for heavier repairs. It is recommended that more data be obtained relative to the economy and usefulness of this facility.

Storehouse and Oil House.—The storehouse and its facilities should be centrally located, preferably close to enginehouse and machine shop. Walls should have plenty of windows and material handling should be expedited by suitable roadways, platforms and racks. The oil and storehouses should be of fireproof construction. Storehouse should be placed so that men will not have to cross enginehouse leads to get materials.

Oil requirements at large terminals necessitate a separate oil house with attendant, located conveniently to enginehouse and machine shop. At a terminal where oil requirements are light the oil house may be made a part of the storehouse but separated from it by fire walls. In any case, the oil house should be adjacent to storehouse.

Government Ownership of Railways and the Attack on Valuation

Extracts From an Address June 12 Before the National Association of Credit Men

By ALFRED P. THOM,
General Counsel, Association Railway Executives.

Under a system of government ownership, the rates would still have to be fixed by a governmental tribunal—just as now—the only difference being that then, on one side, would be arrayed all the taxpayers demanding that those who use transportation shall pay for it in the proportion to the use they respectively make of it, and, on the other, some of the users of transportation would be asking that a substantial part of the burden be shifted from their shoulders to the shoulders of the general taxpayers.

In the event of government ownership, the railroads would no longer be taxpayers and contribute in the way of taxes to the public treasury, for they would then belong to the government, which does not tax its own property. It would withdraw from the states the power to tax railroad property, because they cannot tax property belonging to the federal government. This would mean that more than $300,000,000 per year, now paid by the railroads in the way of taxes, would have to be made up to the state and Federal governments from other sources.

These cardinal facts are undeniable. Whether or not particular rates are out of line or rates on special descriptions of traffic are too high, is, as above stated, a matter to be determined by the appropriate governmental tribunal. Manifestly, the controversy, whatever may be its merits, is not a justification for discarding the system of private enterprise and ownership which has wrought the marvel of achievement now standing to its credit, and for replacing it with a system of governmental operation which is opposed to the fundamental conception in the American mind of the proper relationship of government to business and which failed to command the public approval the only time it was ever tried in American history.

It may be that there is distress in the agricultural industry, although I

am happy to believe that conditions there have greatly improved since the low prices following the deflation after the war, and that the industry along with all others is distinctly on the up-grade. If, however, there is distress in that or in any other industry, it is not my purpose to be indifferent to it or to minimize it.

But we must look at this problem, which involves a broad governmental policy, in a clearer way than from out of the shadow of the dislocations and readjustments following the war. We must look beyond the temporary distress of even a great industry, and try to safeguard and perpetuate the forces and the policies which will establish and maintain on an enduring foundation the welfare and prosperity of our people.

Danger of a Government Founded on a Transitory Condition.—We must remember that in times of distress, there is danger, in a democracy such as ours, that discontent may seek to translate itself, without consideration or delay, into a fixed governmental policy. Nothing could be worse than a government founded upon a transitory condition of distress and discontent. It is especially dangerous in respect to an essential industry which has become subject to political control, for designing politicians will at once seize upon it as a means of promoting their political ambitions. This great transportation industry is now being made to struggle not only with its own internal business problems, but with constant political agitation started by designing and ambitious men, some with conscience but mistaken, others utterly devoid of conscience and thinking alone of their own political fortunes.

Let us not forget that in these latter days we have erected among us a marvelous temple of constitutional liberty, where our patriotic citizens gather to worship and to give thanks for the blessings of representative government and for the safeguards of human rights which our constitution guarantees. No blind Samson of distress and discontent must come near its pillars to pull it down in wreck and ruin upon the heads of our devoted people!

It is interesting to observe that this clamor for governmental ownership and operation of railroads comes just at the time when the government, already owning sufficient tonnage by water to move the water-borne commerce of the world, is acknowledging its inability to operate it successfully; is seeking from Congress a subsidy to make good deficits which it declares to inevitable, and, in the absence of a subsidy, is seeking to find private purchasers to do the business which it acknowledges it cannot itself do.

Government Operation During and After the War.—It is also interesting to observe that those who advocate governmental ownership as a means of securing lower rates, must confront the object lesson furnished by governmental operation during and after the great war, when the government, for the 26 months of federal control, according to the statement of the Director General of Railroads, excluding the six months guaranty period in 1920, suffered a loss of approximately $1,200,000,000—an average deficit for the 26 months of over $46,000,000 per month—not a deficit of earnings to meet operating expenses, but a deficit in respect to paying operating expenses and a return on the property used, which the President and Congress declared to be fair during a period in which the carriers were excluded from participation in the prosperity enjoyed by all other industries arising out of war profits.

There is little in this experience to justify the hope of lower rates under government management, unless the general taxpayer is to supply the defficiency which the lower rates create; in other words, unless the taxpayers are willing to pay a subsidy to support rail transportation which they have refused to pay in support of water transportation.

The Attack on Valuation.—But driven to the conclusions I have stated by the inexorable logic of these facts, and realizing that they cannot hope for lower rates if the values found by the government for these properties are respected, the advocates of government ownership have already inaugurated a campaign for the destruction of that valuation.

That valuation, with the additional investment which has since been made up to Dec. 31, 1921, amounts, for Class I roads, to $19,734,683,000. A convention of the advocates of government ownership recently held proposes to reduce these figures to $9,734,683,000 by the simple method of striking off ten billions of dollars.

Let us apply to this proposal a very simple test—employing the method used by President Markham in his

striking demonstration of the fact that the Illinois Central is not over-capitalized:

The railroads included in this valuation, as of Dec. 31, 1921, owned 68,718 locomtives, 56,900 passenger train cars, and 2,378,682 freight train cars. The existence of these assets and the use of them in the public service cannot be disputed. Estimating them at even one-half of their present cost, they would be worth $4,643,328,800. Add to this, cash working capital and the value of materials and supplies on hand, which at the time mentioned approximated $652,677,192, and we have an aggregate of $5,296,005,992. Deduct this from the $9,734,683,000 which these advocates of government ownership declare to be the proper value, and there will be left, as the value per mile of the 241,399 miles included in the valuation, a little less than $18,400, which covers the roadbed and track, bridges, tunnels, signals, telephone and telegraph lines, lands, yards and buildings, including shops, roundhouses, stations, and terminals everywhere, some of which are located in great cities and are of vast value. When this figure of less than $18,400 per mile is contrasted with the cost to the various states of constructing the hard-surface county roads, which averages, according to the Department of Public Roads of the U. S. Department of Agriculture, $36,801 per mile, and in which nothing has to be included for tunnels, signals, telephone or telegraph lines, yards, shops, roundhouses, station buildings, terminals or any other buildings, lands for right of way, or the cost of entering any municipality or city, and relatively little for the construction of bridges and for the elimination of curves and grades, the monstrous scheme of confiscation proposed by these advocates of government ownership begins to disclose itself.

The foregoing will give an idea of the extremes of confiscation to which these advocates of government ownership are willing to go.

We are told that in the early days there were gentlemen, piratically inclined, who made large sums out of trustful investors by a system of railroad wrecking, in which they were said to be past masters. These men were pygmies as compared with the railroad wreckers of today; for the latter, by the simple fiat of a Congress which they hope to control, are seeking to deprive the owners of these properties of ten billions of dollars of the value placed upon them by an independent and informed government tribunal.

But they contend that a large part of the investment in these properties was made by the public which paid the rates, and the amounts thus paid, in excess of certain standards which they fix, does not belong to the railroads but to the public; and they further claim that no part of the increase in the value of lands owned by the railroads, over their original cost, can be included in the value of the railroad properties.

The thing which the railroad produces and sells is transportation. The price of it has for many years been fixed by the government, and was always the amount permitted by law. It was sold in the market on terms either prescribed by governmental authority or otherwise as lawful as the prices received by the farmer for his cotton or his grain.

Suppose a party of public men were to come forward now with the claim that the prices received for cotton and for wheat during the late war were excessive—wrung from the necessities of the people by the exigencies of war—and, if invested in the farmer's business or in additional lands or other property, the public and not the farmer created and is the owner of the values thus acquired. What would the farmer say to such a proposal?

Lands in cities and in rural districts the country over have increased in value many thousand fold due to the building of railroads, the establishment and growth of cities, the development of markets, the construction of highways, and the carrying out of drainage and irrigation programs at public expense. The growth in the value of lands due to these causes is known as "the unearned increment." Will the individual owner admit that this increase in value does not belong to him? And yet, when part of these lands happen to belong to a railroad company, this daring political philosophy denies that the increased value is the property of the railroad owners. If this claim is ever admitted, the same principle will apply to other classes of property essential to the public, when the system of governmental regulation is extended over them.

The Wear and Care of Wire Rope

Useful Suggestions for Care of Wire Rope Given in Paper Presented Aug. 30 at Annual Meeting of Lake Superior Mining Institute

By WILLIAM CONSTABLE
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Wire rope is in itself the most reliable of all structural materials, but it is also a sensitive and complex structure. Therefore, in order to obtain the most satisfactory results from a wire rope, it is necessary to follow certain definite rules, and if these rules are ignorantly or otherwise disregarded, short rope life and often disaster is the result. Hence, by the application of a few of the more important rules by the user towards the care of wire rope, the abuse will be considerably reduced and better rope life will result.

Hoisting and Haulage.—The ropes used for this class of service range in sizes anywhere from 1 in. dia. to 2¾ in. dia. and lengths suitable to meet conditions.

Drums used for hoisting and haulage purposes should be made of cast steel material whenever a cast iron drum shows wear, and as large in diameter as practicable. The use of a grooved drum is far better and more economical than a flat face drum. Where a flat face drum is used it is absolutely necessary that the first layer wind uniformly to guide the additional layers because the first layer of rope on the drum is the groove for all additional layers. This can be greatly aided by using a steel starting piece to guide the first wrap of the first layer so that the rope may be wound on the drum in a true helix, otherwise the rope may wind in a wavy manner causing severe abrasion to the rope due to this condition.

When installing a new rope on a flat face drum, care should be taken not to hammer hard each additional wrap of idle rope against the adjacent wrap already on the drum, it is only necessary to tap with a light hammer and wooden block to bear against the adjacent wrap of rope. If this is done too forcibly it will reduce the pitch of the first layer by interlocking of the idle wraps of first layer and the second and additional layers of rope will be subject to severe abrasion due to close winding of the first layer. Furthermore, to avoid interlocking of ropes on installations winding only one layer on a small diameter straight face drum with a severe fleet angle existing, it is preferable to use a left lay rope when overwind rope winds from right to left and under-wind rope winds from left to right. A right lay rope is preferable when the under-wind rope winds from right to left and the over-wind rope winds from left to right. There should always be at least three to four turns of dead rope left on a drum.

Where severe rope abrasion occurs at flanges when changing from one layer to another, or at other points due to the crossover, it is advisable to order a little reserve rope to permit the cutting off of the rope at the drum end at frequent intervals. Where there is not much reserve rope on the drum and where the abuse is quite severe and requiring frequent cutting at the drum end, it has in some cases been found satisfactory to cut 30 in. at a time every three or four weeks. In other cases these need not be cut oftener than three or four months. This will dpend upon the total rope life and the rapidity of rope wear on the drum.

As stated before a grooved drum is more economical and wherever feasible it is strongly recommended in preference to a flat face drum. Where a grooved drum is used, and rope wound more than one layer the pitch of the grooves should be not more nor less than ⅛-in. larger than the rope diameter; this will give an ideal winding condition of the first layer, if the fleet angle is not too great, and will permit a good groove condition for the second layer. If the pitch is too small it is apt to cause crowding or rubbing of one wrap of rope against the other and if a second or third layer is added on a close pitch groove drum the additional layers of rope will be subject to severe abrasion. The grooves should also be made of a slightly larger radius than the rope so that the rope will not wedge or pinch in the groove.

Another advantage of a grooved

drum is that the rope in the groove is given a far better and continuous support, hence the actual pressure of rope on drum becomes less and more uniform and not concentrated as when a flat face drum is used. It will be found that most of the latest high speed hoist installations are using grooved drums. It is the general practice for the diameter of a drum to be not less than 60 times the rope diameter.

Sheaves.—The head sheave of a shaft hoist installation has a great bearing on the life of the rope and if they are not made of the proper material nor machined true and their upkeep is neglected, good rope service will not be secured. Sheaves are generally made of cast iron, cast steel, or maganese steel. If a cast iron sheave does not wear with any given rope tension, it will be satisfactory to use cast iron. If, however, the cast iron sheave wears so much as to influence the life of the rope a cast steel sheave should be used, but if a cast steel sheave wears so much as to influence the life of the rope, then a manganese steel sheave should be used if other operating conditions permit.

It is very necessary that head sheaves be machined very true, round and in perfect balance if good rope service is to be secured. It is also very important that the sheave is in alignment with the center line of the drum or if the drum is not entirely filled it should be in line with the center of that portion of the drum on which the rope winds, to avoid sheave flange wear as much as possible, which is caused by the rope fleeting back and forth across the drum. It is almost impossible to exercise too much care and attention for the prevention of side flange wear, but is also very dangerous if a portion of the sheave flange cracks and breaks out, throwing the rope out of the sheave groove.

With high speed hoists, the head sheaves should be as light as possible. Where a sheave of heavy section is used, there is a tendency for the ropes to slip on the sheave when the velocity of winding changes quickly which will wear the rope very severely. If sheaves become badly scored or the groove diameters are worn small from a rope which has been in service for a considerable time, it is most advisable to change the sheave or turn out the groves before a new rope is installed, to insure the best condition for rope service in the future. A pinching groove condition should be avoided with a new rope as this results in a restriction of the rope rotation and the strand movement. The general practice is to have a groove diameter slightly larger than the rope diameter and the following groove diameters are recommended for new and remachined grooves:

For rope ¾-in. to 1¼-in. dia.—$\frac{1}{16}$-in. larger grooved diameter.

For ropes 1$\frac{5}{16}$-in. to 2½-in. dia.—⅛-in. larger grooved diameter.

For ropes 2⅝-in. up—$\frac{3}{16}$-in. larger grooved diameter.

In regard to the proper diameter sheave for a certain size rope, the general practice is to figure it at 72 times the rope diameter, but 80 times the rope diameter would be better.

Fleet Angle.—The fleet angle is the maximum angle formed by a line running through the center line of the head sheave at right angles with the center line of the drum and a line running from the center of the head sheave to the center line of the outermost wrap of rope on the drum. This angle should be kept as small as possible. The permissible fleet angle for shaft hoists is stated by some authorities as a maximum of 1½ degrees, but others allow 2 degrees as a maximum. These values are governed by a number of conditions, for example, a 2-degree maximum fleet angle may be permissible for large diameter grooved drums, but without question where a small diameter straight-faced drum is used a maximum fleet angle of 1½ degrees is excessive. Too large a fleet angle results in an overlapping of the rope on the drum which should be avoided as it will mash, distort, and severely abrade the rope causing a short rope life. Many ropes have been decreased in life from thirty to fifty per cent because of this condition. As the fleet angle is governed by many conditions, before installing a new equipment it would be very advisable to submit all data to the rope engineer for his examination, study and suggestions from a wire rope viewpoint.

Attachment to Cage or Skip.—Where the rope is attached to the cage or skip it is most advisable to use a wire rope socket with zinc attachment, when properly made, will develop the full strength of the rope.

If a socket attachment is used it will be necessary to cut off the end of the rope at frequent intervals and re-socket it again. This should be done at six equal intervals during the life of the rope and the rope should be cut anywhere from 2 to 20 ft., depending upon the deterioration of the rope near the attachment. This is necessary because a rope running over a head sheave of a hoist is restricted in rotation due to the friction of the rope in the groove of the sheave. This accumulates an excess of twist in the rope at the socket. This accumulation of twist together with the constant vibration of the running rope, concentrating at the socket attachment, causes an additional fatiguing action in the steel wires which requires that this portion be cut off at frequent intervals. An additional length of rope should be ordered to meet the condition.

Where clips are used for an attachment, be sure that the "U" bolt bears on the slack side of the rope. Otherwise a crimp is placed on the tension side of the rope, damaging it and at this point the rope generally fails. Be sure to use a sufficient number of clips to properly hold the rope and the larger the rope diameter the greater number of clips are required. Clips should be spaced so that the distance between center line of clips is equal to six times the rope diameter. It is very important that the nuts are tightened up frequently when the rope is put into service, because the stretch of the rope reduces the holding power and may cause an accident. It is also considered advisable to re-clip an attachment in case of re-socketing. Where the clip attachment is used it is advisable to use a solid thimble so that the pin hole may be offset from the center line of the thimble a distance equal to one-half the rope diameter so that the pull of the rope may come in direct line with the bear of the pin.

In shaft hoist or haulage work, if a shut-down becomes necessary the rope should not hang in the shaft or lay out on the slope, but both skips or cages should be brought to the surface with the rope wound on the engine drums so that if thoroughly lubricated they will be protected from deterioration.

Haulage.—In inclined haulage work a good track equipment is very essential. Care should be taken regarding the true alignment of sheaves and track rollers. These should be well lubricated so that the rope may ride with the least possible friction. Rollers often stop or freeze fast and though made of softer material will cause wear on the rope. Knuckle sheaves should be located at points where change of direction of rope is such that the length of the arc of contact is six times the rope diameter or more. The knuckle sheave diameter should not be less than 48 times the rope diameter for 6x19 construction, nor 84 times for 6x7 construction and should be equipped with properly machined grooves.

Abrasion and rubbing of rope on an incline haulage should be avoided by the proper installation of rollers. Considering the rollers on a uniform grade, it is found economical to use the wide mouth type of track roller, which should be not less than 6 times the rope diameter, and they should be spaced 25 to 30 ft. apart. If it is found that this system of track equipment wears down quickly it may be necessary to install steel sheaves.

In both hoisting and haulage work it is very important to avoid high accelerating stresses. It may not, on the surface, appear dangerous to the wire structure, but if the comparison were made of the micro-structure of the steel before and after such stressing a visible change would be perceptible. It is by far the wisest plan to apply the load gradually so that the rope may not be subjected to sud-stresses, which have a great bearing on the life of a rope.

Overloading a wire rope is also very detrimental toward good rope life and should be avoided and guarded against. The safety factor should not be less than that specified in the wire rope catalogs and for short lengths of rope the safety factor should be increased.

Ropes on Excavating Shovels.—A good many of the most modern shovels today use wire rope exclusively for digging in place of chain which was formerly considered indispensable for shovel work. Ropes for this class of service range in sizes from ¾-in. dia. for boom ropes up to 2⅛-in. dia. for main hoist ropes, as used on one of the largest type.

When installing a new rope on a shovel care should be taken not to

damage the rope in any way nor cause it to become kinked, for any abuse incurred by a shovel rope during installation may cause an early failure. After removing an old rope, and before installing the new one, examine all the sheaves carefully and check the groove diameters accurately to see that they have not been worn small nor scored by the old rope. A sheave groove which has been worn down to the diameter of the worn rope, which is generally less than the diameter of the new rope, will cause a pinching action on the new rope resulting in the new rope becoming damaged in the first few days of operation. It would be much cheaper to re-machine the worn groove to the proper groove diameter or replace the sheave before installing the new rope.

Avoid the rubbing of the rope on the steel structure of the boom by installing guide rollers. Where such rollers are installed the bearings must be kept well greased so they will always be free to revolve. If this is neglected and rollers become fast the ropes continually rubbing over them will severely wear the rope and shorten its life. Precautions should be taken against sudden heavy digging stresses as the normal load stresses run high in this class of work. Furthermore, a good operator will avoid reckless handling which is apt to impart severe damage to the ropes. The rope should wind uniformly on the drum and avoid the piling up of the rope on the drum in one place, as this will mash and abrade the rope and greatly reduce its life. It is also important where possible to have the drum of sufficient diameter and length so that the rope may wind upon it in one layer.

Seizings.—As stated before, a wire rope is a mechanism of somewhat complex construction and its original efficiency can only be retained as a unit when it is not distorted. In the manufacture of wire rope great care is exercised to twist the wire in the strands and the strands in the rope under uniform tension. Therefore, it is very important that the ends of a wire rope are properly secured with the proper number of wire seizings. If the ends are not properly secured, the original relation of tension, as manufactured, will be disturbed and the maximum service will not be secured, due to the fact that some strands are carrying the greater portion of the load.

When cutting steel wire rope, it is very essential to place three sets of seizings each side of the cut to prevent disturbing the uniformity of the rope. Use annealed iron wire for seizing purposes.

Right and Wrong Way of Handling Rope.—When installing a piece of wire rope it is not probable that anyone would intentionally mishandle it, nevertheless, a word of caution should be given. In the first place, a wire rope should not be handled like a manila rope for it is structurally different. It must not be uncoiled like a hemp rope. A wire rope received in a coil should be unrolled on the ground like a hoop and straightened out before attempting to pass it around the sheaves. Where long lengths of rope are shipped on reels the reels should be jacked up on a shaft at a point convenient to the installation and allowed to unwind slowly until the entire length of rope has been installed. Avoid kinking a rope when installing it, for if a rope is kinked during installation, it is almost certain to fail in service at that point.

When handling a Lang lay rope never wind directly from the reel or coil to the drum. Lay out rope in full length if possible or set the reel or coil as far from the drum as possible. A Lang lay rope is more springy than a regular lay and should be carefully installed and where possible always keep tension on the rope.

Lubrication.—Lubrication of a wire rope is highly important, as it performs two necessary functions; that is, to reduce internal and surface friction and to prevent corrosion. Ropes being operated in vapors or fumes, or in water must be thoroughly lubricated to prevent corrosion. There is not much value in a lubricant which will run easily and drip from the rope. The ideal lubricant is one which will not harden upon exposure nor at low temperatures and which can be made thin enough to penetrate. Therefore, a lubricant applied hot will generally give good service because in its heated condition it will penetrate and then upon cooling will congeal into a plastic filler throughout the rope.

A wire rope operating over sheaves must be well lubricated because it is

subjected to considerable internal friction and in order to overcome this friction the lubrication must be such that it will work in between the wires of the strands, thus permitting the wires to be free to adjust themselves to all degrees of bending.

Connections.—Wherever a spliced eye, clip or clamp connection is used it is very necessary to use a wire rope thimble, around which the rope is passed to protect it from becoming mashed and distorted when strain is applied to the rope.

Reverse Bending.—Reverse bending; that is, passing of a rope over one sheave in one direction and over a second sheave in the opposite direction, so that the two bends are diametrically opposite. This is an exceedingly severe condition of rope service and its use should be avoided wherever possible. The use of a reversed bend will wear out a wire rope more rapidly than straight bending. The result of a reverse bend is similar to taking a sample or wire and bending it backward and forward until it breaks at the point of bending. It is quite surprising how few reverse bends are required to cause failure, therefore, where a wire rope is subject to similar reverse bends short rope life will result.

Explosibility of Ammonium Nitrate

A preliminary study of the properties of ammonium nitrate that influence safety in storage, handling and use has been completed by the U. S. Department of the Interior through the Bureau of Mines. This work is conducted in co-operation with the National Research Council, which established a committee for the investigation of the explosibility of ammonium compounds, as the result of a number of explosions of ammonium nitrate, in chemical works and other places. The committee is composed of members of the Bureau of Explosives, Army, Navy, Fixed Nitrogen Research Laboratory, and Bureau of Mines. Ammonium nitrate is extensively used in making mining and military explosives, and in the manufacture of fertilizers. The Bureau's experiments have yielded definite data on the effects of heat, pressure, and density of packing on the stability and sensitivity of ammonium nitrate.

Steam Shovels Operated by Compressed Air

Methods Employed in Excavating at Cleveland, O., Described in Mine and Quarry

By RALPH T. STONE

The adaptability of compressed air to various angles of construction work recently found an interesting application in the city of Cleveland, in laying several miles of water intake mains from the Kirtland Pumping Station to the new Baldwin Reservoir and purification plant, in the highest part of the city.

The intake consists of two 5-ft. lock bar steel pipes laid side by side in a trench 15 ft. wide. The depth varied

Air-operated Shovel in the Cut.

from about 9 ft. to 20 ft. according to the conformation of the surface.

For about 6,000 ft. the mains run through Wade and Rockefeller Parks, which are contiguous, consisting of a long rather narrow parkway traversing one of the finest residence sections of the city and crossing several heavily traveled streets.

A. B. Roberts, director of utilities, decided not to permit the use of steam equipment in the parks in order to avoid damage from the smoke and soot. As the work was prosecuted day and night it was also necessary to avoid the noisy exhaust of steam engines.

Air Power Adopted.—It was found that by installing an air compressor plant this result could be accomplished, while the contractor could utilize standard excavating equipment which can be used on future work where steam is not objectionable.

Peter F. Connolly of Boston, Mass., the contractor, installed two Sullivan angle compound belt driven air compressors. They have a rated capacity of 784 cu. ft. per minute at 250 r.p.m. and supplied an abundance of air at 125 lb. pressure. Each compressor was driven by short belt connection from a General Electric 220 volt three phase slip ring motor of 150 h. p. The air intakes were led under the floor to the outside of the building and were hooded over to prevent foreign matter from entering the cylinders.

Alternating current for the compressors was supplied by the Cleveland Electric Illuminating Co., special transformers being installed just outside the building.

One of the Air-operated Drag Lines Making the Surface Cut, in Wade Park.

From the compressor house a 6-in. main led about 4,000 ft. north and a 4-in. main for about 3,600 ft. in the other direction along the trench. These mains were equipped with numerous tees for machine connection.

Adaptable Steam Shovels.—The excavators consisted of three Erie Model 'B" shovels, mounted on sectional track with interchangeable boom equipment. In accordance with the necessities of the work they were used as steam shovels, drag line excavators, clam shells or cranes for placing the pipe.

A Keystone excavator was used for back-filling the trench after the pipe was laid and tested.

Reheating Air for the Shovels.—An ingenious method was used in furnishing the air power to the machinery. Two-inch hose connected the shovel to the main. It was led through one of the openings in the side of the sectional track and was connected with the hollow swivel pin on which the shovel revolves. Thence it ran into the boiler and there was reheated by means of a light wood fire in the boiler.

Considerable rock was encountered and was drilled with hand hammer drills of the self rotating type. In the hard pan, compressed air spades with long handles were found very useful. For tamping the fill solidly under the pipes, compressed air tamping tools or sand rammers were used.

On the 6-in. line a water trap was installed at a low point for the purpose of drawing off accumulated moisture before delivery to the shovels and drills.

As the work progressed both day and night, proper illumination was important. A number of locomotive type steam turbine generators furnished current to 150 watt incandescent lamps. These turbines were light enough to be handled by two men, required no foundation and ran excellently on compressed air. They were placed wherever needed along the line and connected to the air main with ¾-in. hose. In addition each shovel was equipped with a generator on the roof.

The work was continuously under the close personal supervision of A. B. Roberts, director of utilities of the city of Cleveland; A. V. Ruggles, commissioner of water; G. W. Bowers and F. R. Sullivan, assistant engineers in direct charge of the work.

Early Railroad Grading Camps in Kansas

An interesting account of a railway grading camp of 45 years ago is given by W. G. Norton in the Santa Fe Magazine, from which we quote the following:

When the Santa Fe line was built from Florence to Ellinwood, Kan., (in 1879) it was my good fortune—as a green farmer's boy with an empty purse, a rare appetite and a strong span of mules—to be induced or rather projected into a railroad grading camp, most of which was made up of western Kansas farmers whose crops had dried up and whose families were in need.

The veterans of the gang dubbed us "Sorghum Lappers" and "Clod Hoppers," but it did not take long to develop mule skinners and scraper rustlers from such material.

My first job was to hitch my span of mules to one end of a four-horse evener, and my partner hitched his mule to the other end. The evener was attached to a big breaking plow, with a stout Dutchman at the handle. It was our duty from 7 until 12 and from 1 until 6 to plow dirt enough ahead to keep the scraper gang on the jump, and had we fallen down ever so little there would have been another set of teams in our place without any argument.

The work was supervised by husky gang bosses, who knew how dirt could be moved from cuts or dumps, built with neatness and dispatch, mingled with much sweat of the brow and language that was far from pious.

The housing problem was settled by whatever means happened to be at hand. Some had tents; some built dugouts or shacks from old lumber, and many lived in covered wagons of the prairie schooner type, while some resided in bunk-houses, the beds of which usually were infested by hordes of hungry grey-backs and bed bugs.

The majority of the men formed mess crews and boarded themselves. Beans, bacon and bread were staples of consumption on week days, and potatoes, dried apples and peaches, rice, eggs—boiled, scrambled or fried—oceans of black coffee and flap jacks comprised the Sunday menu.

Sunday was not a day of rest. Washing muddy clothes, repairing shacks and harness, mending tents, etc., took up most of the time on such days. Satan seldom found an idle hand around a grading camp.

Sometimes we would play scrub games of baseball, and sometimes practical jokers would successfully ply their favorite pastime on other members of the gang. I recall one of the latter instances very vividly: "Dad" Poor, a man of unusual avoirdupois, was enjoying his after-dinner nap in his covered wagon. One of the boys quietly worked "Dad's" long shirt-tail out through a crack in the side of the wagon. drew it down as tightly as was practicable and pushed about a dozen tacks through it. He then ran around to the back of the wagon and called out to "Dad" that his mules were loose. No pen of mine could possibly describe what happened next! Perhaps the eruption of a volcano or an earthquake or a live tornado might afford a fair comparison.

"Dad's" shirt was constructed of very stout cloth, but not stout enough; and his vocabulary was sure spilled a-plenty. No one in the gang, however, told who actually did the job, so that murder was avoided.

Camp fire stories were not lacking during these moments of relaxation. I shall never forget the remark made by a typical Irishman after he had quietly sat through the telling of several Irish stories. He jumped to his feet and slapping his thigh, spit this out: "I say to yez, there's not more than half of the d— lies yez tell on the Irish that is true."

The weather was unusually fine during this particular summer, and the grading was finished in time for the track laying. I worked at every job: Mule skinner, scraper, holder, patty and grade finisher. Two of us remained on the job for two weeks after the rest of the force had gone, ditching in cuts and picking up remnants from the fills. The camp was T. A. Butler's, near Lyons, Kan.

A Correction.—A typographical error made us credit the article "The Explosive Contractor," in our August issue, to the Atlas Power Co. The article was prepared by the Atlas Powder Co.

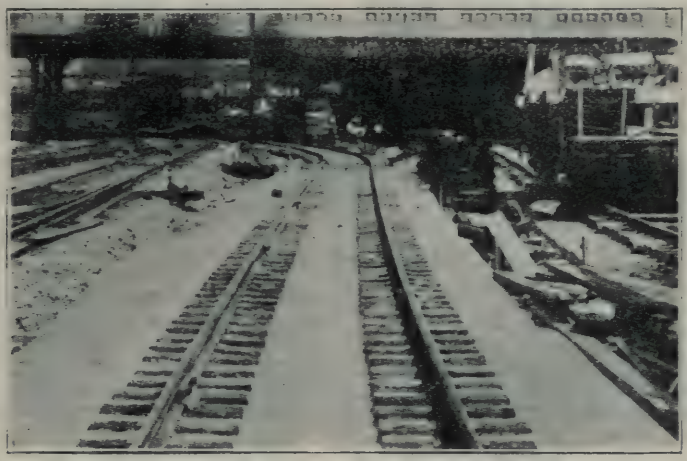
Concrete Slab Supports for Chicago Union Station Tracks

New Tracks in Service Since 1920 Give Remarkably Low Maintenance Cost

Owing to the low supporting power of the clay sub-grade, the approach and station tracks of the new Chicago Union Station are carried on concrete slabs. Although this concrete track support is not unique, it is probably the most extensive installation that has yet been made. The total area at present authorized amounts to 1,125,000 sq. ft. of 10 in. slabs, of which nearly 800,000 sq. ft. is reinforced either with wire mesh or deformed steel rods, while the remainder, which was used between tracks in the trainsheds, is plain concrete. An interesting description of the installation is given by Joshua D'Esposito, chief engineer of the Chicago Union Station Co., Chicago, in Railway Engineering and Maintenance, from which the matter in this article is taken.

Approach Tracks Slabs.—Beginning near the east line of Canal Street, about 600 ft. north of Lake Street and extending south to the north end of the north station platforms between Washington and Madison streets, a 10-in. slab reinforced with wire mesh is being laid to serve as a support for approach tracks and crossovers of the usual ballasted construction. The same type of slab is being used under the crossovers and approach tracks between the south end of the south station platforms (just north of Harrison Street) and Polk Street, under the tracks and crossovers between Taylor Street and Roosevelt Road, and from Canal to Harrison streets under the "joint tracks" used for transferring cars between the north and south yards of the development.

All necessary conduits and pipes are laid in concrete ducts below the subgrade, after which a 6-in. layer of cinders is spread over it. This layer of cinders is rolled to a plane parallel to the required finished surface of the slab. No other subgrade drainage is provided, but a system of drains is being built to take care of water falling on top of the slabs. Precast inlets or catch basins are placed between all tracks at intervals of about 8 ft. and the slabs are sloped so as to drain to them. The latter are connected to pipes running across the yard which in turn empty into longitudial drains that carry the water to sumps located at the low points of each yard. Automatic electric pumps transfer the water from the sumps to the river.



Completed Section of Station Track.

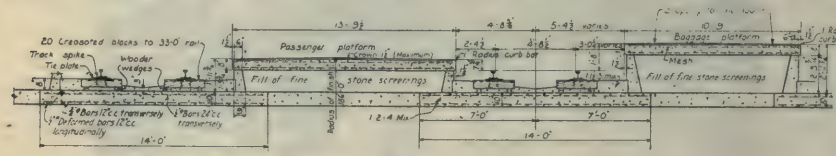
Construction Features.—Aggregates are dumped as near as possible to the location of the slab to be laid in order to avoid unnecessary wheelings. It is often possible to unload cement directly from the car door to the mixer. An ordinary paving mixer is used. Because of the necessity for maintaining traffic it is necessary to complete a portion of the work at a time. The tracks are laid 13 ft. center to center and the slabs are constructed in sections 13 ft. wide by 21 ft. long. The sections are laid in a checkerboard pattern, alternate sections being placed after the first ones have hardened. Tar paper joints are placed between adjacent sections. A wooden strike-off is used to strike the surface level with the forms, further finishing being done with wooden floats.

On these slabs the usual ballasted track of heavy construction is laid. Twenty creosoted red oak ties, 7 in. by 9 in. by 8 ft. 6 in. are used to a 33-ft. rail. The depth of ballast below the ties varies from 6 to 10 in., on account of grading the slabs to drain to the inlets. The rail is standard Pennsylvania 130-lb. section.

Approximately 440,000 sq. ft. of this type of slab will be used. The work is being done by contract, at prices varying from 33 ct. to 43 ct. per sq. ft., depending on the time and conditions of the work. As the slab has to be laid a little at a time, and the work so arranged as to affect train movements as little as possible, this cost is higher than it would be under better working conditions.

Preliminary loading tests on the subgrade indicated that it had a supporting power of between 2,000 and 3,000 lb, per square foot. It is believed that with the track construction above described the pressure on the subgrades will not reach 1,000 lb. per square foot as a maximum. With such a low pressure it is thought that, even if the slab does crack to some extent, no trouble will result.

Station Tracks of Special Design.—Adjacent to the station platforms and including some of the special work at the ends of the trainsheds an altogether different type of track construction is being used, although the concrete slab is quite similar to the one described above. It is 10 in. thick and 14 ft. wide, and is reinforced at the top and bottom with mats of reinforcement as shown. The drainage inlets are located in the center of each track instead of between tracks. Instead of ties in ballast, creosoted wood blocks 6 in. by 8 in. by 2 ft. 6 in. are set in a concrete roadbed resting on the concrete slab. The thickness of this concrete varies from 3 in. between the rails, and below the blocks to 8¼ in. at the outside edges of the blocks. The concrete is a 1:1½:3 mix. Alternate sections are placed as in the slab, care being taken to make sure that the joints coincide. Finishing is done with a wood float.



Details of Slab Construction

Between the rails and surface is shaped to form a trough which carries the water to drainage inlets at 80 ft. intervals. This trough is finished with a 1:1 mix after the rest of the roadbed has been placed.

The rails are spiked to the blocks, using 6½-in. spikes and 11-in. by 7-in. by ¾-in. tie plates, before starting to place the roadbed. Wedges are then driven under every sixth block to bring the track to grade. The gauge is held during construction by wooden struts spiked across between clocks at frequent intervals. After the concrete has been placed there is no further need of the struts and they are removed. The rails used on the station tracks are 100-lb. Pennsylvania section.

The concrete base slab used for the station tracks, reinforced with steel bars, has cost from 40 ct. to 51 ct. per square foot, depending upon prices of materials at the time the contracts were let. Approximately 420,000 sq. ft. of it will be used. This type of roadbed was adopted because of the ease with which it could be kept clean. The trains on these

tracks will be running at low speed, which, it was thought, will eliminate any possible objection to the lack of resilience in the solid concrete construction. Some of these tracks which have been in place for several months have been serving as approach tracks for the present Union Station farther north and are handling heavy traffic at a much higher speed than they were designed for or will ever be required to stand when the station project is complete.

Plain Slabs Beneath Platforms.—Separate platforms on opposite sides of each track are being provided for passengers and baggage. Each platform will serve two tracks, one platform being exclusively for passengers and the next exclusively for baggage. Thus there will be no interference between passengers and baggage trucks. Passenger platforms will be 13 ft. 9½ in. wide and 8 in. above the top of rail; baggage platforms will be 10 ft. 9 in. wide and 20 in. above the top of rail.

In order to prevent the soft blue clay foundation from working up into the cinder fill below the platforms and permitting settlement of the track slabs, 10-in. slabs of plain concrete of 1:3:5 mix will be laid between the track slabs and at the same elevation, thus making a continuous pavement across the trainsheds. The space between these platform slabs and the platforms proper will be fileld with fine stone screenings. Approximately 265,000 sq. ft. of this type of slab will be placed.

Conclusions.—The first slab was laid during the summer of 1920, under the slip switches in the south approach tracks in the block just north of Polk Street and was placed in service the following November. It was the ballasted type of construction. These tracks have been carrying 198 scheduled trains per day, each of which must back into the station before leaving, or back out after arriving. In addition there has been considerable transfer, interchange, freight and mail movement so that the total number of movements has been in excess of 500 per day. Under that traffic the ordinary type of track structure would have required heavy maintenance, which would not only have been expensive but would have obstructed train movements in a region that is congested at best. Furthermore the track would never be in as good condition as we are now able to keep it continually, at very low cost.

The tracks in the block just south of Polk Street do not contain any special work and were built at the same time (1920) as those described above, and of the same heavy ballasted construction, but without the concrete slab; they carry the same traffic. Ordinarily, due to the special work, track maintenance in the block north of Polk Street would have been much higher than in the block just south; actually maintenance of the tracks containing the special work, and laid on a concrete slab, has been less than a quarter of that required in the other block without special work and without a concrete slab. This saving will pay for the concrete slab in a short time.

Device for Determining Air Movement in Tunnels

In studies of mine and tunnel ventilation conducted by engineers of the Bureau of Mines, U. S. Department of the Interior, various smokes are used to determine the flow of air, the direction of the currents, and the rate of mixing. A specially devised instrument for generating streams of sulphur trioxide smoke has been found convenient for such purposes; it is also especially useful in some places where fire for generating smokes is not permissible.

The apparatus consists simply of a glass tube containing fuming sulphuric acid on granular pumice stone, attached to a rubber syringe bulb. When a squeeze of the bulb blows air through the tube, a stream of dense white smoke evolves, which follows and makes visible the movement of the air currents. A description of this instrument is given in Serial 2505, by S. H. Katz, associate physical organic chemist, and J. J. Bloomfield, junior chemist, which may be obtained from the Department of the Interior, Bureau of Mines, Washington, D. C.

Motor Buses in Wisconsin.—Reports to the American Electric Railway Association show that five electric railway companies in Wisconsin are operating 50 motor buses over 540 miles of route.

Design of Street Railway Track in Paved Streets

Problems Faced by Maintenance Engineers of Public Utility Companies Outlined in Paper Presented Before State Engineers' Section of the Annual Conference of Mayors and Other Public Officials

By HOWARD H. GEORGE,
Engineer, Maintenance of Way, Public Service Ry. Co. of New Jersey

I believe that, as engineers, you will acknowledge the impracticability of preparing a definite specification for street railway track construction which would be suitable for all possible conditions. Neither is it desirable to set up one, two or three types as standard and say to the railway industry, "Use this type here, or that type there." Such a specification or standard design would work an unnecessary financial hardship on a large percentage of street railway companies, and would probably not give the best results to a great many others who were financially able to build in accordance with it. And not only must economy in first cost be considered, but economy in subsequent maintenance as well. And last, there is still the fact to face that track wears out and must be completely rebuilt and it should be so designed in the first place as to permit the maximum amount of salvage at the time of reconstrution. This feature is equally desirable in the case of pavement. This is an item which is apt to be frequently disturbed during the life of a track, and the cheapest in first cost is often the most expensive in the long run.

Standard specifications for the miscellaneous materials entering into a track can and should be prepared, but to say that any given combination will result in the best track for all conditions would be about as ridiculous as to say that there is one best automobile or one best anything else that is manufactured by assembling a number of different units together. The experience of others is a good guide as to what may be expected from any particular type of construction, but this experience should be determined from careful personal observation and not from camouflaged reports.

Factors That Determine Type of Track Construction.—Street railway engineers are confronted with a very large and important problem in the determination of the type of track construction most suitable for the conditions on their property. Several factors enter largely into this question. Probably the first is the maximum weight and type of equipment to be operated and volume of traffic to be carried.

The next factor is that of the condition of the soil on which the track must be placed, and its ability to support the loads. This subject, together with that of the actual stresses existing in the track, is one to which, unfortunately, too little attention has been paid in many cases in the past, and has undoubtedly been responsible for many cases of failure of the track structure and consequently of the paving.

Soil which, under ordinary or natural conditions, would be entirely unsuitable for supporting any kind of track structure, may be made entirely satisfactory in several different ways. It may be accomplished by the use of cinders or other light, porous material rolled into the soil so as to form a binder.

Sometimes crushed stone or slag will best answer this purpose, and in the latter case it may be that the run of the crusher will accomplish the best results rather than the use of a uniformly graded ballast. Then again, conditions may be such that drainage of some kind or another should be resorted to. The existence of storm water sewers in the streets has, in many cases, a very large effect on the condition of the sub-surface soil.

The Matter of Ballast.—The last important factor is that of economy, and it is in meeting this requirement that the engineer is called upon to exercise his greatest ingenuity and is largely responsible for the many different details of track construction in use by electric railway companies in this country today.

One engineer will advocate stone ballast. According to his idea 6 in. of such ballast should be placed un-

der the ties. Another engineer, while agreeing that stone ballast is the proper material to use, will say that 4 in. under the ties is sufficient. Still another engineer will say that just as satisfactory results are obtained by the use of gravel, crushed slag, or perhaps cinders for this purpose. Probably all three are obtaining satisfactory results, and it is here that local conditions play a very important part.

In one locality crushed stone may be scarce, it may have to be hauled a long distance, while gravel is obtainable locally at a low cost. In the other case, it may be that good cinders are obtainable, whereas neither stone nor gravel are to be had at a reasonable cost. Or it may be that the natural soil condition is such as to make it unnecessary to use any other than the natural soil for ballast.

Ties and Tie Plates.—In the matter of ties, some engineers specify white oak ties because they can still obtain them locally, or within a reasonable distance of their property. But it would be out of the question to require every property to use white oak for this purpose, for it could not be obtained in sufficient quantities at any price. There are plenty of other woods which answer the same purpose for electric railway track conditions equally as well at considerably less cost. Many otherwise inferior classes of woods are made entirely suitable for railway ties by the use of a proper preservative treatment.

The use of tie plates may or may not be necessary or desirable. This depends entirely on the weight to be carried by each tie, and the compressive strength of the wood at right angles to the fibre. If the rail base and the tie at the rail bearing point are wide enough to provide a bearing area sufficient to keep the unit compressive stresses within the proper working limits and prevent excessive cutting during the life of the tie, then tie plates are not necessary, and their use adds nothing to the life of the track and only serves to increase its cost.

Question of Rails and Joints.—As to the question of rails and joints, we are again confronted with a large assortment from which to choose. Heinz with his "57 Varieties" has nothing on us when it comes to selecting a rail, and the worst of all is the fact that the rail manufacturers are apparently willing to continue to make new sections as often as a railway company with sufficient influence makes a request for one, sometimes making that company pay for the cost of the new rolls, and sometimes absorbing this cost in its general manufacturing overhead. In many cases the differences between rails are so slight as to be hardly noticeable. Here again weight of equipment, volume of traffic, design of wheel treads and flanges, as well as details of the track structure must enter into the discussion. I will not attempt to express an opinion of the relative merits of the various types of rails, either as to details of design or on what are ordinarily referred to as T-rails, as compared with what are commonly known as girder rails, as this is a subject that would start an argument which would in itself take up more time than is available at this meeting.

It is generally admitted that street railway engineers are divided into two camps, one of which advocates a rigid track structure, that is either steel ties encased in concrete or some form of concrete beam support, while the other advocates an elastic or resilient supporting structure for their rails.

The Pavement Types.—A concrete pavement in a track area can be put down at a very reasonable figure, and when it is first laid it looks fine. But unfortunately rails have a peculiar habit of breaking occasionally, joints go bad and the concrete has to be taken up in order to make the necessary repairs, and it is almost impossible to make an entirely satisfactory repair job on concrete paving. In addition, when the time comes to entirely rebuild the track, the salvage on the paving is practically nothing.

Brick and wood block pavements both have found considerable use in track areas, but while more economical in first cost than granite, and although under some conditions giving satisfactory results, in the majority of cases they are not the most satisfactory pavements for track areas, and economy in first cost is very often responsible for subsequent expensive paving maintenance and practically no salvage value at the time it becomes necessary to entirely rebuild.

The same statement is true for asphalt paving, and especially where the asphalt has been laid in direct contact with the rails. Experience has shown

that, where asphalt paving is laid in the track area. at least one and preferably two or more rows of stone block should be laid on each side of the rail. There is always some vibration of the rail and where the asphalt is laid in direct contact with the rail this vibration opens up a small joint between the rail and the asphalt into which water penetrates and the action of the vehicular wheel loads on the pavement at this point soon disintegrates the asphalt immediately adjoining the rail.

Stone block pavement on the other hand, while costing more in the first place, lends itself readily to repairs, has a long, useful life under the most severe traffic conditions, and after years of service can generally be reclipped and relaid at a relatively small cost and give a pavement as good as new. As a matter of fact old block which have been reclipped should make a better wearing and more dependable pavement than new block, because of their previous long exposure to the weather, and the fact that in this way all soft stone has been eliminated.

Effect of the Other Utilities.—If no other utilities occupied the streets the problem of track and paving maintenance would be simplified. The problem of the location of the various utilities in the public streets becomes more complicated every year, not only to the municipal engineer, but those of the utilities as well. The street railways, as one of the utilities, is the only one which occupies the surface of the street. In addition to the street railways there are no less than six other utilities which may occupy the streets in some manner.

We have sewers, water, electricity, gas, telephone, steam mains and sometimes mail tubes, all of which occupy more or less space and require frequent service connections to the adjacent structures along the street. Some streets also carry exceedingly large trunk sewers and water mains which are frequently independent of the regular local mains. Practically all of these utilities have manholes and valve boxes which extend to the surface at frequent intervals and these often form quite a collection at street intersections.

Instances have been noted of as many as 11 manhole covers at one location within the confines of two 50 ft. intersecting streets. When there are many manhole heads in the vicinity of the car track, curves and special trackwork, it becomes a nice problem to design tracks to dodge them, and their presence usually causes great difficulty in properly constructing and maintaing the tracks and track pavement.

There is a need for closer co-operation among municipal and utility engineers in relation to matters of location, and many cities are finding it very desirable to set up bureaus charged with the design and location of sub-surface structures.

Prior Construction of Sub-Surface Utilities.—The construction of sub-surface utlities prior to the construction of street railway tracks of a permanent character is greatly to be desired, and until the streets are properly graded, curbed, paved and have all their normal underground sub-surface mains in place, it is not desirable to attempt to construct tracks of a permanent nature.

The sidewalk spaces might be more generally used for locating many utilities, although in some places there may be objections from a legal viewpoint relating to the use and occupancy of such spaces. And, of course, vaults under the sidewalks occasionally cause some trouble.

My understanding, however, is that there are no legal objections to utilizing sub-sidewalk space for utilities, whatever personal objections property owners may have. Also in most places vaults under sidewalks are illegally located, even though tolerated by complaisant officials. On new streets these objections would not obtain to a very great extent.

No attempt has been made to consider what may be the best location for all of the sub-surface utilities. They are mentioned because the subject seems to call for their discussion, and when we see the complicated installations of pipes and conduits in some of the streets of our large cities, we are forced to conclude that much of the confusion could have been avoided if early attention had been given to their proper location.

Location of Tracks in Street.—The central location of tracks in streets is considered by all competent authorities to be the best for cities. Such a location is the most logical, convenient and safest for the public. Where

possible, on wide thoroughfares, there are good reasons for considering the use of parked spaces for the tracks. Such spaces or areas are safer for all other forms of street traffic and for car passengers. Better car schedules can be maintained due to less interference from vehicular traffic, and parked areas are more quiet, as there are no pavements acting as sounding boards. Also the tracks are cleaner, thus lessening noise due to wheels passing over grit on the rails. The railways can more economically maintain the parked strip and the tendency to neglect such track, in times of stress, is much less than where pavements must be opened in order to make track repairs. Probably four times as much effective track work can be done in parked areas, as compared with paved areas, for an equal expense.

One of the most frequent sources of trouble with tracks in central locations comes from disturbances of the sub-grade which are due to settlements over cross trenches made for service connections or for additional mains of one kind or another. The railway has had little or no control over such trenches and until the present time it has been difficult to convince municipal highway engineers of the importance of special inspection of all such openings, not only during the work, but also during the restoration of back-fill and to prevent undue haste in repaving.

This matter, of course, is not directly concerned with the location of the utilities as a part of the original design, but it is to be considered in respect to the street railway as a located utility, upon which, at present, is placed the burden of care and maintenance, not only of tracks but also of the pavement, wherein this utility distinctly differs from all others occupying our streets. No other utility is obliged to install and maintain pavements for others to use. Any undue influence causing unwarranted expense to the railway in such circumstances should have our attention, and the co-operation of municipal and utility engineers is of vital importance in lessening the trouble incidental to poor track and pavement conditions which are all too frequently caused by outside influences, entirely beyond the control of the railway.

Who Should Pay for Paving and Its Maintenance.—A paper of this character can hardly be considered complete without some discussion of the very important subject of track responsibility for paving and maintenance of the same in railway tracks in city streets. What should be the responsibility of the street railway company with respect to the cost of installation and maintenance of pavement? Payment annually of large sums by street railway companies for pavements and their maintenance secures nothing of value to the utilities.

The materials which go into pavements are really purchased by the railway company and turned over to the municipality for the benefit of the community at large. The railway company derives no special or peculiar benefit from the construction of the pavement.

On the contrary, it is a burden rather than a benefit. This principle has been established by no less an authority than the Court of Errors and Appeals of your own State of New York. The duty to pave and maintain the paving of the so-called track area is imposed for the pecuniary benefit of the municipality. It is not dependent upon conditions that the street railway creates, such as the interference with the surface of the highway due to the presence of the track in the street.

A Relic of Horse Car Days.—The obligation to pave and maintain the pavement in the tracks is a relic of horse car days. In the old days when all the cars were drawn by mules or horses, the paving charge or tax levied on the street railway was admittedly a fair and equitable assessment. Undoubtedly the horses pounding on the narrow strip between the rails, day in and day out, all the year round, did wear the pavement and the street car operator of those days probably acknowledged the responsibility readily enough, but those days have long since passed.

With modern track construction and electrically operated cars, the damage done to the pavement from the operation of cars is relatively small, and in any event, is limited to the pavement immediately adjoining the rails. This fact has been recognized in the State of Connecticut, where the paving burden has been materially reduced by limiting the responsibility of the railway companies to a width

of 8 in. on either side of the rail. Street car loads are carried down to a substantial bearing area over the sub-soil through the rails, ties and ballast, and not through the pavement. With modern rail joints the pounding of the cars over loose joints has been practically eliminated. What then is the principal cause of paving damage?

Damage to Pavements by Motor Trucks.—I was very much interested in reading the editorial review in the Engineering News-Record of May 10, 1923, on the subject of damage to pavement by automobile trucks. A survey of twenty large cities throughout the United States showed that trucks weighing, with their loads, from 15 to 25 tons are not uncommon, and such loads, operating over paving at relatively high speeds, are the cause of most of the cases of pavement failures, sometimes even breaking through the concrete paving foundation. A truck load of even 25 tons distributed over four wheels gives a wheel concentration heavier than will be found on almost any ordinary 8-wheel trolley car.

Tests of impact stresses conducted recently by a committee of the American Society of Civil Engineers show that these are actually much higher than for electric railway cars. The conclusion reached in the Engineering News-Record survey was that the pavements generally as constructed in the last 10 yrs. will break down comparatively rapidly under the extreme truck loads of 15 to 25 tons which now prevail to some extent in most large cities. I personally know that we have such loads in New Jersey, for I have had occasion to check total weights of trucks operating over our ferry between Edgewater and New York City, and have found weights on four wheels as high as 23 tons.

Electric Railways and Taxes.—It is a notorious fact that the electric railways are the most heavily taxed industry. Statistics show that if you add up all the taxes, state and local, for the steam railroads in the State of New York, these companies pay about 27.3 per cent of their net profits in regular taxes. The electric railways, say. 44.4 per cent, telephone and telegraph, 16.2 per cent, and gas and electric, 23 per cent. Referring to Virginia, for instance, in 1921 the electric railways paid in taxes 36.6 per cent of their total net revenue, an increase of over 100 per cent since 1917, when they paid 13.61 per cent, and these figures do not include any federal taxes.

The American Electric Railway Engineering Association statistics show that, taking the country at large, about 6.5 per cent of all our gross operating revenue goes into taxes and about 3.5 per cent into paving and similar charges, a total of about 10 per cent of the gross operating revenue for taxes. This represents approximately ½ ct. of the fare paid per passenger. And this fact must be remembered, the rider pays the paving bill, whether it is in the form of increased fare or increased municipal taxes.

Street Railways Spend $22,000,000 Per Year for Pavements.—Comparable figures on the mileage of electric railways then and now show that in 1890, when the electrification of lines was just getting under way, there were about 8,123 mi. of single track operated by street railway companies. In 1917, according to the United States Census, there were 44,835 mi. Although the only justifiable basis for the imposition of the paving impost disappeared with the horse cars, the companies today pave and maintain a right-of-way more than five times as long merely because, when the change was made from the horse-drawn vehicles to electrical propulsion, no consideration was given to changed conditions as far as the resultant wear on pavement was concerned.

As the street railway companies extended their lines the paving burden became proportionately heavier, for of course, the outlying lines did not pay as well as those of the thickly populated towns, while the cost of paving increased more or less uniformly throughout the system.

Nor is this the whole story. The type of pavement used at the time these paving taxes were imposed was usually nothing more than a rough gravel, cobble stone or macadam paving, comparatively inexpensive types as compared with those required to meet the demands of modern heavy vehicular traffic. Thus the process of piling up the burden on the street railway company is still going on.

A conservative estimate of the total amount expended each year for paving by street railway companies is about $22,000,000, of which about $15,000,000 is for construction and about $7,000,000 for maintenance. This is slightly less than 25 per cent of the estimated total net income of the industry in 1921. In other words, if the industry could be relieved of these obsolete imposts it would mean an increase of approximately 25 per cent in their net income, and would also mean a healthier condition of the traction systems, and greater ability to maintain their lines in conditions to meet increased demands upon them.

Street railway fares are not readily susceptible to changes from time to time. Only under the stress of extraordinary circumstances are increases in fares granted. Periodical variations in the rate of fare merely to cover taxation would not be tolerated by the public.

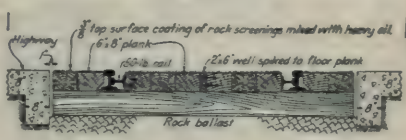
If the private merchant finds that the selling price of his various wares is not sufficient to meet the needs of his business there is nothing to prevent his increasing the sale price to meet the requirements, but this is not so easy with a utility like a street railway company.

With the merchant an increase of a cent on each article sold may produce the necessary revenue, and this is usually a small percentage of the total cost of the article, but in the case of a car ride an additional one cent, which is the smallest unit of our monetary system, added to the rate of fare means anywhere from 10 to 20 per cent increase.

Relief from Paving Burden.—The question of relief from the paving burden is a vital one to the street railway industry. Relief has been granted in a certain relatively small number of cases through special legislation. A good beginning has been made and the sentiment for complete relief is gaining ground among thoughtful people. It would appear to be high time that laws making burdensome paving requirements should be repealed and the justice of the street railway's claim for relief from the responsibility for paving expense recognized, and this burden placed where it properly belongs.

Old Bridge Ties as Crossing Plank

Second-hand 6 in. by 8 in. bridge ties can be utilized to advantage for highway crossings, writes G. E. Stewart, assistant engineer, Southern Pacific Ry., in Railway Engineering and Maintenance. The sketch shows the construction of an improved highway plank crossing using 50-lb. guard rail. The old 6 in. by 8 in. ties are placed directly on the track ties and



A Crossing Built With 6 In. by 8 In. Timbers.

fastened with lag screws and the joints are poured with hot oil or asphaltum.

This is an ideal layout for 90-lb. or 100-lb. rail, the tie plates elevating the rail above the stringers a distance of ¼ in., and allowing the planking to be covered with a top coating of rock screenings. A 3 in. strip can be substituted for the guard rail if preferred.

Locomotive Production

The Department of Commerce announces August shipments of railroad locomotives from the principal manufacturing plants, based on reports received from the individual establishments. The following table compares the August, 1923, figures with the previous month and with the corresponding month last year, as well as totals for the year to date, compared with a year ago, in number of locomotives:

	Aug. 1923	July 1923	Aug. 1922	8 Mo. Total Jan. to Aug. 1923	8 Mo. Total Jan. to Aug. 1922
Shipments:					
Domestic	259	211	130	1,802	472
Foreign	13	28	21	114	169
Total	272	239	151	1,916	641
Unfilled orders (end of month):					
Domestic	1,406	1,652	926	.....	.....
Foreign	81	86	109	.....	.....
Total	1,497	1,738	1,035	.....	.....

Construction News of the Railways

Bids Opened for Moffat Tunnel

Bids were opened Sept. 12 at Denver, Colo., for the construction of the Moffat Tunnel. Ulen & Co., New York and Chicago, bid $6,075,000 for the work. The tunnel will be 6 miles long, extending through James Peak, west of Denver.

Rail Extensions in South Texas Proposed

The Rio Grande City & Northern Ry. Co. has filed an application with the Interstate Commerce Commission for authority to build a line from Sam Fordyce to Mirando City, Webb county, via Rio Grande City, a distance of 85 miles. The San Antonio & Arkansas Pass R. R. is contemplating an extension from Rio Grande City to Falfurrias. Both extensions will serve parts of the Rio Grande Valley not now served. While the S. A. & A. P. has not yet applied to the Interstate Commerce Commission for authority to construct its contemplated extension it is known to be under consideration.

B. & O. to Construct Yards Near East St. Louis

The Baltimore & Ohio R. R. has purchased a large tract of land bordering its tracks near the Collinsville Road and opposite the Monks' Mound, near East St. Louis, where it will construct yards to enlarge its facilities.

A. C. L. Building Extension in Florida

Grading is under way for the line of the Tampa Southern R. R. (Atlantic Coast Line) between Bradentown, Fla., and Sarasota. Cook & Co., Bradentown, have the contract.

Grading to Be Started on Branch Line in Canada

Some construction work on the extensions of the Edmonton, Dunvegan & British Columbia Ry. will be done this year. James Mohler, contractor for the construction work, is now at Grand Prairie looking over the ground. Later he will go on to Peace River to ascertain conditions there and what equipment is available. New lines are to be built west from Grand Prairie and west from Berwyn.

Orient Railway Plans Improvements in Mexico

Investment of new capital in the completion of the Kansas City, Mexico & Orient R. R. through Del Rio to Mexico City and through Presidio to Chihuahua City and Topolobampo, on the Pacific coast, is more probable as a result of recognition of Mexico by the United States, in the opinion of W. T. Kemper of Kansas City, Orient Mo., president and receiver. Early in August Mr. Kemper obtained, through President Obregon, financial aid from Mexico sufficient to build from Falomir to within 30 miles of Presidio, Tex., the incomplete Orient line extending northeastward out of Chihuahua City. Further aid in closing the remaining 110-mile gap from the new northern terminus to Alpine is made more likely with the recognition of Mexico by the United States, it is believed.

Subway Contract at Fort Wayne, Ind., Let

The J. F. Cole Construction Co., Fort Wayne, Ind., has been awarded the contract at $88,420 for subway work at Lafayette Street, Fort Wayne.

Contract Let for 1,200-Mile Railroad in China

The Northern Construction Co., Winnipeg, Canada, is reported to have been awarded a contract for a $20,000,000 railroad from Canton to Chenteg, China. The line will be about 1,200 miles long and will extend through a mountainous country, necessitating much tunnel work.

New York Central May Build Short Line in Michigan

The New York Central R. R. is reported to be making surveys in Hudson and Cement City, Mich., for short stretches of track connecting the New York Central with the Cincinnati Northern. The connection will permit the movement of coal from the Ohio and Kentucky coal fields to Detroit and northern points through Adrian over the Monroe branch and over the Ypsilanti branch connecting in Cement City.

Southern Pacific to Spend $50,000,000

The Southern Pacific R. R. has announced a $50,000,000 improvement program for the Pacific coast states. The projects, many of which are under contract, include double tracking from Tehachapi to Seivert; completion of double tracks from Bakersfield to Mojave; building of the Natron cutoff, affording an alternate route to Portland; a new line in the Imperial Valley; large tie and timber treating plant at Los Angeles Harbor; new steel bridge over Colorado River, and a new passenger station at Yuma. The program is centered in Southern California. There is to be 15 miles of rail renewal on the Duarte branch and 23 miles on the Van Nuys branch at a total estimated cost of $440,000. The Los Alamitos and Newport Beach branches are to be reballasted at an estimated cost of $87,000, and the line between Palmdale and Saugus is to be reconstructed at a cost of $65,000. Construction of the Natron cutoff in southern Oregon at an estimated cost of $15,000,000 will assure Southern California fruit and vegetable growers rapid delivery of box shook from that region. The new line in Imperial Valley, 21.7 miles long, will extend from Calipatria east and south to a point near Holtville. Extensions totaling 23.4 miles are now being made in Kern county.

Bids to Be Taken Soon on $130,000 Underpass at Joliet

Elgin, Joliet & Eastern R. R. has approved plans for a subway under its tracks on the Bluff Road at Joliet, Ill., and probably will take bids shortly for the work, which will cost about $130,000.

Gary, Ind., Street Railway to Extend Its Lines

The city council of Gary, Ind., has approved the franchise of the Gary Street Ry. Co. for the extension of their lines to the new $15,000,000 tube mills and thence to Miller Beach.

San Francisco Municipal Railway Plans Extension

Plans and specifications are being prepared by M. M. O'Shaughnessy, city engineer, of San Francisco, Cal., for the Eureka tunnel route of the Municipal Railway. The estimated cost of the new line is $1,050,000.

Heavy Construction on Logging Line in Washington

The Coats-Fordney Logging Co., according to reports from Hoquiam, Wash., is doing heavy construction work building a logging railroad northward from the present end of their road. about 18 miles north of Aberdeen. They still have a body of uncut timber which extends 12 miles before reaching national forest territory. Their railroad will eventually be built to take out all of this, which is between the Wishkah and the Wynooche rivers. The construction work on the railroad, the first mile of which is expected to be ready for the steel in 30 days, is very heavy, cuts as much as 70 ft. deep being necessary, and one trestle in the first mile being 650 ft. long. Engineers estimate that the cost of the first mile will be $75,000.

D. & R. G. Ry. May Extend Branch

The Denver & Rio Grande R. R. is contemplating extending its Durango-Farmington branch a distance of 18 miles down the San Juan Valley.

New Line in Nevada

The Interstate Commerce Commission has granted permission for the building of Idaho Central R. R., between Wells, Nev., and Rogerson, Idaho. In the permit granted, it was stipulated that the work on the new railroad must begin before Jan. 1, 1924, and be completed before June 30, 1925. The new line will tap the copper camp at Contact, where, it is said. a large body of ore has been uncovered. Heretofore, however, the ore could not be shipped to the smelters because there were no railroad facilities available. This is a Union Pacific Ry. project. It is understood bids will be taken shortly after Oct. 1.

Oklahoma Railroad Proposes Extension

The Beaver Meade & Englewood R. R. (C. J. Turpin, general manager, Oklahoma City, Okla.) has applied to the Interstate Commerce Commission for authority to extend its line from Forcan to Hooker, in Oklahoma, a distance of 40 miles. The extension would be the first section of a new line which eventually would go to Des Moines, N. Mex.

Chicago Terminal Improvements of Illinois Central

Extracts from Paper Presented July 11 at 53rd Annual Convention of American Society of Civil Engnieers

By D. J. BRUMLEY,

Chief Engineer, Chicago Terminal Improvement, Illinois Central R. R.

It is predicted the City's Loop, or downtown business district of the immediate future will extend from the Chicago River on the north to East Roosevelt Road on the south, the east and west boundary lines being respectively Lake Michigan and the south branch of the Chicago River.

A railroad terminal to best serve the purposes of a transportation machine must lie within easy and convenient reach of this great business center and furnish adequate and uninterrupted means of transportation for suburban and through passenger service, and local freight business. In order that these three classes of business may be served adequately and without interference, they each should comprise separate and distinct units of the terminal development, have ample connections with other railroads for expeditious interchange, and proper division for adequate vehicular traffic accesses and local transportation connections.

The Suburban Passenger Terminal.—The suburban passenger terminal is located between Randolph St. and the Chicago River and practically alongside Michigan Ave., with stations at Randolph St., Van Buren St., and East Roosevelt Road, along the eastern side of the business section.

The plans developed thus far provide for a stub-end terminal at Randolph St. with two track levels each consisting of six tracks of sufficient length to accommodate not less than 12-car trains. The operation of suburban trains throughout the terminal will be on tracks used exclusively for this service and without interruption from the operation of through passenger, freight, or switching trains. From Randolph St. to East Roosevelt Road the operation of the suburban trains will be confined to four main tracks; from East Roosevelt Road to 47th St. six main tracks; from 47th St. to 67th St. four main tracks; from 67th St. to 115th St. three tracks, and from 115th St. to the southerly suburban terminus at Matteson two main tracks. At the East Roosevelt Road through passenger terminal the suburban tracks will occupy a tunnel, with station facilities below the level of the through passenger facilities. On the main line south, the suburban tracks will occupy the westerly side of the right of way where for the major portion of the distance they will be most convenient to the patrons of this service.

The suburban terminal at Randolph St. will be completely reconstructed and that at Van Buren St. will be greatly extended and enlarged, with suitable subway connections under Michigan Ave. to each.

The Local Freight Terminal.—The railroad company's local freight terminal lies east of Michigan Ave. and occupies an area of approximately eighty acres between Monroe St. and the Chicago River. The new freight terminal will be constructed with depressed driveways and track levels and will occupy a space of 55 or 60 vertical feet below the boulevard and viaduct levels on two sides of the property. The heavy vehicular traffic street accesses will be underneath the boulevard viaduct approaches.

The through passenger terminal will be located at the intersection of Michigan Ave. (the principal north and south boulevard thoroughfare east of the river) and East Roosevelt Road (the future principal east and west boulevard thoroughfare). The area for the through passenger terminal development, comprising an area of 102 acres, extends from East Roosevelt Road to 31st St., a distance of 2¼ mi. with an average width of 640 ft., and has a frontage of 693 ft. on East Roosevelt Road where the passenger terminal buildings will be located.

East Roosevelt Road Boulevard, 118 ft. wide, will front the station on the north and extend into Grant Park, east of the railroad, on the north side of the railroad, on the north side of the Field Museum. Provision is made in the ordinance for the construction of a street car tunnel underneath the right of way and tracks of the Rail-

road Company immediately north of the new station with a stairway connection from the street car tunnel to the station building. An ample park boulevard will adjoin the station on the east, and for a distance of a half-mile Indiana Ave., with no sidewalk on the east side, will be a widened traffic street adjoining the terminal area on the west

In addition to these accesses, the through passenger terminal will have immediate connections with the Railroad company's suburban service, and will be alongside two surface lines and one elevated line serving the principal residence districts of the city and will be adjoining a rapid transit subway, when built, in accordance with the city's present plan.

The Terminal Station Building.—The terminal station building will be opposite the southerly end of Grant Park and will serve as a fitting southerly finial for this section of the park area. Immediately east of the Terminal station building is the Field Museum of Natural History with which the station building will harmonize in general architectural appearance and color.

The Lake Front Ordinance has so fixed the elevation of viaducts and subways in the vicinity of the through passenger terminal area as to permit of the greatest latitude in developing tracks, platform, baggage and mail levels. When the growth of the lake front passenger terminal should require, it is practicable to construct one through track level and two stub track levels and have easy and permissible gradients on the main track approaches for each level. The subway at 18th St. is placed at such elevations as not to interfere with the track approaches to the lowest track level.

The East Roosevelt Road viaduct is the northerly limitation as to viaduct construction, the 23rd St. viaduct being the southerly limit, within the passenger terminal area. Within this area and with the elevation of viaducts and subways as they have been fixed by the Lake Front Ordinance, it is possible to develop a passenger terminal with a capacity of approximately eightly tracks, none of which will be less than twelve hundred feet in length. In addition to the space required for the terminal station building, baggage, mail and express facilities, there will be room within the area to create a mechanical terminal of sufficient capacity to care for steam and electric locomotives using the terminal and also for the storage of through passenger equipment.

The easterly portion of the through passenger terminal area. Within this Road will be completed and ready for service at the time the suburban service is electrified, leaving the present through passenger station facilities for use under steam operation during reconstruction.

It is planned to develop the suburban area at Randolph St., the local freight terminal at South Water St., and the through passenger terminal at East Roosevelt Road in such a manner as to make possible the complete development of the air rights over the entire area in accordance with the provisions of the zoning ordinance, passed by the City of Chicago on April 5, 1923.

Track Arrangement.—From East Roosevelt Road south to 51st St., a distance of approximately five miles, the right of way is nowhere less than 300 ft. in width, except from 31st to 41st Sts. where it is 250 ft. From 51st St. to the southerly City limits the right of way in all places in 200 ft. or more in width.

The general track arrangement where the right of way is 200 ft. in width is:

Construct two industrial switching tracks immediately adjoining the west side of the right of way.

Construct four suburban passenger tracks with separate platforms for local and express service, adjoining the industrial tracks on the east.

Construct four through passenger tracks, with platforms at stations it is necessary to serve, adjoining the suburban tracks on the east.

Construct two through freight tracks and one industrial switching track adjoining the east side of the right of way.

In the territory where the full width of the 300-ft. right of way is developed with tracks and station platforms, it is proposed to construct the through and suburban passenger stations either above or underneath the tracks.

The main line south to the southerly City limits is practically all in track elevation territory where the plane of the roadbed has been raised above the plane of the streets. Prior to the time the various services are electrified, it is planned to eliminate grade crossings of all kinds, whether cross streets,

highways, or other railroads, within the electrified zone.

The Construction Schedule.—Plans have been made to carry out the construction on a schedule which will meet the requirements of the ordinance.

1. Complete the easterly side of the through passenger terminal; complete the rearrangement of sewers and underground facilities; extend the track elevation and grade separation; make changes in grades that are necessitated by the ordinance; be prepared to proceed with the work of electrification; and electrify the entire suburban service within seven years after February, 1920.

2. Electrify the entire freight service north of East Roosevelt Road within three years after the completion of the suburban electrification, or before 1930.

3. Electrify the entire freight service south of East Roosevelt Road within five years thereafter, or before 1935.

4. Electrify the through passenger service not later not 1940 if a certain percentage of the railroads using the Lake Front passenger terminal station are operating electrically at that time.

Work of Electrification.—The work of electrification contemplated in the ordinance embraces approximately 418 track miles.

The electrification system to be used was determined by a commission appointed by the railroad company. This body made a careful study of the Chicago Terminal situation and compared it with the electrifications of similar properties in the United States and foreign countries. The Commission recommended, and the Illinois Central Railroad Company adopted, the 1,500-volt direct-current overhead contact system for use in the Chicago terminal area.

The details for the electrical system are being worked out and it is planned to begin partial operation of the suburban service about the middle of 1926.

The generation of current can be readily provided for either along the shore of Lake Michigan, Lake Calumet or the Calumet River, adjoining the electrically operated tracks, and easily accessible to ample supplies of water.

Tractive power will be converted from high tension alternating current, probably 33,000 volts, to 1,500-volt direct-current in not less than five substations located on the railroad company's right of way. The conversion will be by rotating machines; the machines, transformers, switchboards and auxiliary apparatus being housed in brick buildings of attractive design. The direct current switching and protective equipment will be of the latest high-speed type.

The Overhead System.—The overhead system will consist of steel supports spaced approximately 300-ft. centers for carrying the contact wires, transmission, signal and miscellaneous power circuits. The overhead contact wires will be supported by messengers of high conductivity so that over each track there will be sufficient conductor to supply the power required for that track, thus avoiding the necessity for independent parallel feeders. The contact wires, messengers and their attachment will be made of materials highly resistive to corrosion. The normal height of the contact wire above top of rail will be 22 ft. and it will be so suspended from the messenger as to make its alignment conform to the alignment of the track it serves. Since the electrification will be carried out in progressive steps, the spans constructed initially for the suburban electrification will be ultimately extended to include the the freight, through passenger, and such subsidiary tracks as will be electrified. The track rails being well bonded will form a return circuit for the propulsion current and will be cross-bonded at impedance bond locations, thus avoiding any interference with signal track circuits.

The Suburban Passenger Cars.—Suburban passenger cars are now being purchased for the electrified service, but are being placed temporarily in steam suburban service. The character of the suburban service is such as to make the multiple unit train the most economical system. Provisions are being made for operating two-car semi-permanently connected units of one motor car and one trailer car. These units will have control apparatus in one end of each car and will operate either singly or in trains of two to five similar units. The service provides for a high rate of acceleration and deceleration and a normal balancing speed of 57 miles per hour on tangent level track. The motor cars will be equipped with four 750-volt motors connected in two groups of two motors in series per group with series parallel control.

The braking equipment will be the

electro-pneumatic brake for multiple unit service with 1,500-volt motor-driven compressor. Power for the control and brake operation as well as for the car lights will be furnished by a motor generator set on the motor car, having a 1,500-volt direct-current motor and a 32-volt direct-current generator with storage battery provided as a reserve. The two-car unit will have a pantograph collector on the motor car only. Electrical heaters will be used, the details of which have not as yet been fully decided upon.

The following general dimensions and data apply to the steel suburban cars either built or now under purchase:

Length over buffers—72 ft. 7½ in.
Length inside body—59 ft. 8¾ in.
Length of vestibule—4 ft.
Truck centers—47 ft. 9 in.
Width over eaves—9 ft. 11½ in.
Width over platforms—10 ft. 6 in.
Width inside body—9 ft. 1 in.
Height, top of rail to top of car—13 ft. 5/16 in.
Height, to c. l. of coupler—2 ft. 10½ in.
Height, inside car to lower deck—7 ft. 13/16 in.
Height, inside car to clerestory—8 ft. 4⅛ in.
Weight of present cars light—92,200 lbs.
Seats, cross seats—34 passengers—68.
Longitudinal seats—4 passengers—16.
Total 84.
Windows—42 main windows.

The cars will be equipped with diaphragm enabling passengers to move safely and comfortably between cars and thus make advantageous use of all seats in the train.

By the use of aluminum alloys and a careful redesign of the original steel suburban car, the weight will be reduced approximately 3,000 lbs., reducing the trailer car to approximately 89,000 lbs.

Since there will be no need to purchase electric locomotives for either through main line freight or switching service, or for the through passenger service, for several years, no attempt will be made to work out a design for such equipment at the present time.

Contract Let for First Section of Natron Cutoff

Contract for grading of the first section of the Eugene-Klamah Falls line on the Southern Pacific R. R. Natron cutoff has been awarded to John Hampshire of Grants Pass, Ore. The first unit consists of 31 miles and extends from Kirk to Crescent.

An Improvement in Mudcapping Methods

Better results with increased safety are being obtained at an open-pit mine on the Mesabi Iron Range in Minnesota, by firing "mudcap" shots electrically, instead of by the cap-and-fuse method, writes N. S. Greensfelder in the August Explosives Engineer.

The task required of the explosive is to crack pieces of ore and rock that are too large for the steam shovels to handle. Usually anything larger than 2 cu. yds. has to be blasted. As these masses are encountered by the shovel, they are piled to one side and a number of them are blasted at one

Steel Shelter Used in Open-pit Mines on Mesabi Range as a Protection Against Flying Rocks During Blasting.

time. The Taconite which overlays the ore is so hard that to drill a hole 6 in. deep in it with a jackhammer takes from 2 to 6 pieces of steel and about 2 hours' time. Therefore, mudcapping is more economical than blockholing.

The present method is as follows: The charge, which consists of four or five cartridges of ⅞ in. by 8 in. extra L. F. dynamite, 60 per cent strength, for ore, and 8 to 10 cartridges for Taconite, is placed on top of the boulder and covered with loose dirt or, preferably, the soft, sticky "paint rock," which is readily obtainable in the pit. A No. 6 electric blasting cap with 4 ft. or 6 ft. wires is used in the primer cartridge of each charge. These caps are connected in series and fired by a blasting machine from a shelter at a safe distance.

There are a number of advantages in firing the shots electrically. When the cap-and-fuse method was used, it was a common occurrence for the explosives charges on one or more boulders to be scattered into the rock pile before exploding by the concussion from the detonation of adjoining shots.

This loose dynamite, sometimes containing a blasting cap, was a constant source of danger. It has been eliminated by the electrical method, by which all of the shots are fired simultaneously.

Misfires have also been practically eliminated, and better execution is obtained from the explosives when all the shots are fired at the same instant, because the effect of one shot helps to break the large pieces piled beneath it or on one side of it. By being able to fire a large number of shots instantly with a blasting machine, this part of the blasting operations is no longer conducted at irregular intervals throughout the day while the men are at work, but is usually performed at noon while they are out of the pit.

Every possible precaution is taken to insure safety in mudcapping and other blasting operations. Steel shelters as shown above are provided for the protection of blasters in the pit.

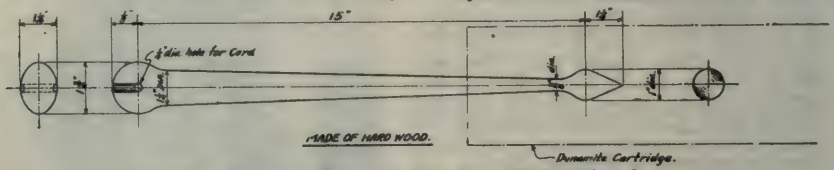
A warning sign describing the blasting signals has been placed next to the main safety bulletin board.

Warning Markings for Railroad Crossing Approaches. — The State Highway Department of New York has devised a new method of marking highways to convey warning of approach to railroad crossings. The first warning will consist of two parallel stripes 1 ft. wide and 5 ft. apart, 230 ft. from the track. The second will be another stripe 125 ft. from the track. The third will be a stripe 2 ft. wide, painted with black and white diagonal bars 25 ft. from the track.

A Method of Loading Deep Well Drill Holes

The question is often asked whether it is safe to drop cartridges of dynamite down deep well drill holes. The usual reply is that practically the universal method is to drop the cartridges into the hole. Frankly, one cannot say this practice is safe. On the other hand, the accidents that can be attributed to this cause are indeed rare. Nevertheless, the handling of explosives is always attended by more or less danger, and the best practice should include all possible safety precautions. In the August Explosives Engineer, Mr. J. Barab describes a simple and inexpensive device for lowering dynamite cartridges, which should interest all who prefer not to drop these cartridges down the hole.

Quite often the well drill holes are ragged and irregular. In such cases, when large dynamite cartridges are dropped into the hole they may get stuck before reaching the bottom. More or less trouble is encountered in removing the obstruction. By use of this spear, the cartridges can be carefully and slowly lowered so that they easily pass the irregular places in the hole, which avoids this difficulty.



Device for Lowering Dynamite Into Deep Well Drill Holes.

Another question that often arises when loading deep holes is whether the dynamite reaches the bottom. By indicating the depth of the hole on the rope attached to the spear, by a mark on the rope, it can readily be determined whether each cartridge of dynamite reaches the bottom.

The spear, as shown in the diagram, is a piece of hard wood about 15 in. long, with the spear head at one end and a hole for a rope at the other. To lower a cartridge of dynamite into the hole, the spear head is inserted into the end of the cartridge, which is then carefully lowered by means of the rope attached to the other end. When the cartridge has reached its destination in the hole, a slight amount of slack is allowed and the

rope is given a sudden jerk; this withdraws the spear from the cartridge without appreciably raising the cartridge. The spear is then pulled out of the hole and the operation repeated with the succeeding cartridges.

Method of Cutting Off Mine Fire by Trenching

An underground fire burning in the Pittsburgh seam of coal near Charleroi, Pa., adjoining the workings of the Youghiogheny & Ohio Coal Co. of Cleveland, O., bids fair to be extinguished after nearly a year of effort. The area of the fire, as nearly as can be determined, is approximately six acres. All known means were tried, without success, to extinguish the fire.

Finally cutting off the fire by means of an open trench was resorted to. This cut is approximately 1,000 ft. long, averaging 45 ft. deep at ends, within 50 ft. of crop, and running up to 65 ft. of overburden at center of cut. It will average 65 ft. wide on top and 25 to 30 ft. in width at top of coal when completed. The material at the center of the cut lay in stratas approximately 15 ft. of yellow clay, 20 ft. of hard shale, 12 ft. of hard sandstone, 12 ft. of hard slate, 3 ft. of very hard sandstone and 3 ft. of hard slate over coal.

Drilling was handled with jackhammers and welldrills, the greater bulk being with well-drill holes, using 40 per cent dynamite. Cuts were made in very low lifts, owing mostly to cave-ins to old workings, as the cut was all undermined with old workings and very dangerous to proceed through with steam shovel. Effective drilling was difficult, because of many holes going through to the old workings, the location of which could not be determined in advance, and the consequent loss of these holes for blasting purposes.

The contract for this work is being carried out by the F. E. Welsh Contracting Co., Inc., of Cleveland, O., and has been in progress since Feb. 10, in which time about 70 per cent of the total yardage of approximately 80,000 cu. yds. has been handled. The equipment consists of an Osgood 29 1-yd. continuous tread revolving steam shovel, two 4-car trains of 3-yd. cars and two 12-ton dinkies of 36-in. gauge. Work is carried on in two shifts of nine hours each, and the yardage runs as high as 800 yds. per day, the shovel handling material that often is too large to pass through the dipper. Large rocks are either chained to the dipper and loaded on the car, or cast back of the shovel to be jackhammered into sizes that will pass through the shovel dipper.

The upper 12 ft. of clay was cast

Excavating to Cut Off Serious Underground Fire from Main Workings of Coal Mine

over the sides and the remainder hauled to waste at either end of the cut by the two dinky trains. The remaining 30 per cent of material is all solid rock and hard slate, and progress is slow and difficult because of cave-ins and mine gas and gaseous fumes leaking through from the fire. Some of the material being loaded is too hot to handle with bare hands.

To date the work has been carried on without accident, but the hazard is greater as excavation comes closer to coal. It is hoped that the work will be completed in a few weeks without accident and in time to load out the coal so as to form an effective cut-off to the fire.

Industrial Notes

The Allied Machinery Co. of America has received advice by cable from T. G. Nee, president of the Horne Co., Ltd., of Japan, that the entire head office staff of the latter in Tokio is safe. The exact status of the merchandise stocks and of the records of the business in Tokio has not yet been determined. Less than one-third of the company's stock is, however, carried in Tokio. None of the 13 branches of the company in Japanese territory was affected by the recent disaster. The Horne Co., Ltd., is, therefore, fully prepared to continue its business of nearly 25 years standing as distributors in Japan for American manufacturers of machine tools, industrial and construction machinery, building materials and allied lines. The Allied Machinery Co. of America, with which the Horne Co., Ltd., is closely affiliated, will continue to handle the affairs of the latter in this country.

The Pawling & Harnischfeger Co. of Milwaukee, Wis., builders of traveling cranes, hoists and excavating machinery, announces the opening of a new office at 1124 Book Bldg., Detroit, Mich., with James Van Buskirk in charge. The company also announces the appointment of N. B. Norris as manager of their New Orleans office at 938 Whitney-Central Bldg.

The Dorr Co., New York City, has moved its Scranton, Pa., office to 536 Miners Bank Bldg., Wilkes-Barre, Pa.

The Sullivan Machinery Co., Chicago, on Aug. 11 formally opened its new western works at Michigan City, Ind. The buildings were completed some time ago, and during the past month the machinery and equipment have been moved from the company's old plant at Chicago to the new quarters. The new plant is designed to permit manufacture of the company's products (consisting, at the western works, of air compressors, diamond core drills, drill steel sharpening machines and cutter bit sharpeners) in the most efficient and economical manner. The new buildings are one-story and equipped with all modern appliances for manufacturing and handling the product rapidly and at low cost. The plant is served by the Pere Marquette R. R.

New Trade Publications

The following publications of interest t engineers and contractors have been issue recently:

Gasoline Locomotives.—A bulletin featurin the Plymouth Locomotive in general construc tion has been issued by The Fate-Root-Heat Co., Plymouth, O. It contains numerous illus trations and descriptions of important con struction jobs, ranging from the Boston dr dock work to the building of 80,000 h. p hydro-electric development in Norway.

Gasoline Shovel.—The Bucyrus Co., Sout Milwaukee, Wis., has just issued a bulleti featuring its new 20-B gasoline operated uni versal shovel, equipped with ¾-yd. dipper It includes a description of the outstandin features of the shovel, together with workin dimensions and specifications.

Drills, Air Compressors, Steel Sharpeners Etc.—The Sullivan Machinery Co., Peoples Ga Bldg., Chicago, Ill., has issued the followin new bulletins: 81-B new Sullivan rotato hammer drills. Describes a new line o rotator drills which have been redesigned t secure increased drilling speed. 77-G Sullivar single state steam driven air compressor. Reprint of former edition. 78-H Ironclad overcutting coal mining machine. This bulleti describes a new type of machine for minin out dirt bands or partings midway of the coa seam so as to prevent mixing the dirt o impurities with the clean coal when it i loaded out. 72-H drill steel sharpeners; new edition, describes the Sullivan drill stee sharpening machines of two types and thei adaptation to making different classes of drill bits and drill shanks on solid and hollow steel as well as for such odd jobs as sharpenin stone channeling machine bits, welding hollo steel, making stone quarry tools, etc.

Power Drag Scrapers.—A 32-page booklet on Sauerman power drag scrapers and Sauerman portable scraper outfits has been published by Sauerman Bros., 428 S. Clinton St., Chicago. It contains thorough and useful information on the design and construction of this type of equipment and illustrates quite comprehensively the many ways of adapting power scrapers to the conditions and requirements of various excavating and material handling propositions.

Thermit Rail Welding.—The Metal & Thermit Corporation, 120 Broadway, New York, has issued a new Thermit rail welding pamphlet. The pamphlet includes detailed instructions, accompanied by illustrations and drawings, showing steps in making the improved Thermit rail weld. Improved apparatus used in connection with Thermit rail welding is described in detail for the first time, as well as illustrations showing results of a 10 years' service test of the Thermit rail weld, also rail bending and drop tests. Instructions for using Thermit for welding compromise joints, constructing frogs and crossings and repairing loose arms of mates and switches have also been included in complete form. At the end of the pamphlet is a discussion of the theory of rail joints.

Track Drainage.—A comprehensive pamphlet on the use of Clay products in track drainage and maintenance has been brought out by the W. S. Dickey Clay Mfg. Co., Kansas City, Mo. It contains an interesting discussion on the importance of a well drained road bed and includes specifications for laying vitrified socket pipe for track drainage purposes, as well as numerous plans for track drainage by the use of this material.

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Buildings

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.
221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*
LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 904 Longacre Bldg., 42d St. and Broadway
RICHARD E. BROWN, *Eastern Manager*

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Vol. LX. CHICAGO, ILL., SEPTEMBER 26, 1923 No. 3

The Economy of Winter Construction of Buildings

We are all familiar with the statement of psychologists that men are the creatures of habit, but few of us undertake to apply that generalization to our own selves with a view to correcting habits that are uneconomic. For example, before present methods of construction existed, our forebears formed the habit of doing practically all their construction work during "good weather," that is in the late spring, summer and early autumn. This habit was at one time economic, for during the "bad weather" seasons the roads were practically impassable, and building materials could not be delivered. Moreover, in those days lime mortar was the only cementing material used for brick and stone masonry, and lime mortar can not be safely used in freezing weather for its hardening depends upon the chemical absorption of carbonic acid gas from the air, a process that does not occur when the lime is frozen. With the introduction of portland cement, however, it became possible safely to build stone and brick masonry as well as concrete in freezing weather, but the age-long habit of regarding winter-built masonry as being unsafe had too strong a grip to be easily overcome, and even yet causes many men to defer construction till "good weather" comes.

Architects, engineers and contractors usually know that most classes of building construction can be economically performed in the winter, but most "owners" of buildings are habituated to regard winter as an unfit construction time, and consequently defer ordering building construction until spring is at hand. But even members of the building profession have not entirely freed themselves from the ancient habit of looking upon winter as a poor time in which to build. They know that the average workman will not do as big a day's work in very cold weather as in warm weather, other things being equal, but they overlook the fact that other things are not equal. The very fact that winter jobs are not so plentiful as summer jobs makes

for labor efficiency, since men will work harder when there is risk of being discharged and of not being able to secure another job quickly.

The prices of building materials are usually lower in winter than in summer, because of the slackened demand, and this reduction alone frequently amounts to a considerable percentage of the total cost of a building. Usually more than half the total cost of a building is the cost of materials. Hence a 10 per cent saving on the cost of materials is equivalent to more than 5 per cent saving on the cost of the entire building.

One of the elements of building cost that is rarely seen in published statements of cost is the cost of delays in the delivery of materials. During the "good weather" seasons both the manufacturing plants and the transportation plants are apt to be overloaded. Hence even if the factory or mill is ready to fill your order the railway or the motor trucks are unable to deliver the material. In the slack season the cost of such delays is eliminated.

If a building is being erected for rental purposes, it is highly important that it be finished either in the early fall or by the first of May. If construction work is planned for the "good weather" season, delays in getting work started, delays in securing materials, and inability to secure an adequate force of workmen at all times, very frequently prevent the completion of the building until after the fall renting date, Sept. 1 or Oct. 1, in consequence of which the owner suffers a severe loss of income. But even where the owner expects to occupy his own building, failure to complete it at the expiration of his lease is sure to cause him both expense and inconvenience. The cost of failure to complete a building at the time when occupancy of it is planned, is an item that seldom appears in estimates of cost but frequently does appear in large figures in any complete summary of costs.

In recent years much has been written about the economic desirability of lengthening the construction season. It has been pointed out that if workmen and construction plant are idle one-third of the time (and it averages longer) then the labor cost of construction becomes 50 per cent more than it would be were it possible to keep them continuously employed. The income of both labor and capital, in the final analysis, must be reckoned by the year; and if only 200 of the 300 available working days in a year are actually worked, the cost per diem, both for wages and for fixed charges on the construction plant, is greater by one-half than it would be were the full 300 days made productive.

This economic argument in favor of continuous building construction is unanswerable, provided a day's construction cost in the winter does not greatly exceed a day's construction cost in summer. We are sure that, with fairly good roads, with modern machinery and devices, with building materials that can be safely used in freezing weather, winter building can be almost, if not fully, as economically conducted as summer building; and that when consideration is given to all the elements of cost (such as labor efficiency, adequate labor supply, promptitude in delivery of materials, interest charges on the land and building up to the time of occupancy) then winter building construction becomes so clearly economic that even the most deep set habit of aversion to it can not survive.

It seems to us that every architect, every structural engineer, every building contractor, should submit estimates of building cost to his clients, demonstrating the real economy of all-the-year-round construction; for, after all, it is the "owner" who is responsible for most of the postponement of building "until the frost is out of the ground." The age-long habit of such postponement still grips the average layman.

American Buildings Withstand Japanese Earthquake

American steel concrete buildings in Tokyo and Yokohama withstood the earthquake shock and are in good condition, according to a cable from Assistant Trade Commissioner G. C. Howard at Kobe. Officials of the U. S. Department of Commerce expressed gratification over the first practical demonstration of the effectiveness of the new so-called earthquake-proof factories and office buildings which have been constructed within the past three years. There are about six of these buildings in Tokyo.

The Building Problem

Editorial in The Architectural Forum

The present difficulties attending the building industry can generally be attributed to one basic factor—the shortage of skilled mechanics. It is perhaps the first time that numerous building operations have been suspended for this reason alone, and it indicates the continued difficulty that will attend efforts to build in proportion to the needs of our population. The reasons for the shortage are many, and no one group is willing to admit the responsibility.

Labor has been able to apply the principle of restricted output which gives it the present opportunity to demand and receive bonuses and unduly high wages; the employers have sidestepped the duty of training workmen and have delegated it to no one else, and the professional interests connected with building have been indifferent. Labor is the only party satisfied with the results of this laissez faire policy, but the whip hand it employs today will bring about a lowering of morale that will be destructive in the end to labor as well as to the other elements of the industry.

The problem must be faced and solved, and from the way in which the groups directly interested have failed to accomplish any results beneficial to the public, it would appear that hope now lies with the professional element of building. The construction industry of this country is too large and important to allow its supply of skilled workers to remain any longer a matter of chance. Sufficient numbers of men, adequately trained, must be made available.

Steps toward establishing working plans for the training of apprentices are being formulated in a number of cities, such as New York, Boston, Philadelphia, Portland, Oregon and others, through the medium of the local Building Congress groups which have been organized and promoted largely through the efforts of a few public-spirited and far-seeing architects. These few local groups have found that the results of intelligent, non-partisan investigation of local conditions when placed before labor and contracting organizations and state educational authorities have elicited favorable attention and the direct promise of co-operation. The Building Congress idea has been sufficiently tested, and its results have been positive enough to prove that it is on the right track to smoothing out some of the building difficulties; it deserves the support and co-operation of every architect, and if in every city there were an influence at work such as exists in those few cities where the Congress idea has taken root, the aggregate effect would be a tremendous power for improvement and helpful stabilization.

Structural Steel Sales in August

The U. S. Department of Commerce announces August sales of fabricated structural steel, based on figures received from the principal fabricators of the country. Total sales of 130,568 tons were reported for August by firms, with a capacity of 224,305 tons per month.

Tonnage booked each month by 176 identical firms, with a capacity of 230,475 tons per month, is shown below, together with the per cent of shop capacity represented by these bookings. For comparative purposes, the figures are also prorated to obtain an estimated total for the United States on a capacity of 250,000 tons per month.

1922	Actual* Tonnage Booked	Per Cent of Capacity	Computed Total Bookings
April	200,968	87	217,500
May	185,065	80	200,000
June	168,894	73	182,500
July	158,012	69	172,500
August	156,559	68	170,000
September	146,827	64	160,000
October	133,037	58	145,000
November	112,367	49	122,500
December	138,737	60	150,000
1923			
January	173,294	75	187,500
February	184,887	80	200,000
March	218,400	95	237,500
April	186,117	81	202,500
May	131,875	57	142,500
June	118,063*	51	127,500
July	116,774**	51	127,500
August	131,770***	56	140,000

*Reported by 174 firms with a capacity of 230,460 tons.

**Reported by 169 firms with a capacity of 229,815 tons.

***Reported by 158 firms with a capacity of 224,305 tons.

Fire Loss in August.—The losses by fire in the United States and Canada during the month of August, as compiled from the daily records of "The Journal of Commerce," reached a total of $24,474,300, as compared with $27,490,750 in July and $21,579,500 in August a year ago.

Retail Prices of Building Materials

Average prices paid Aug. 1. 1923, by contractors for building materials delivered on the job. These prices are secured through the Bureau of the Census and published monthly by the Division of Building and Housing of the Bureau of Standards, United States Department of Commerce.

The report as published by the Division of Building and Housing gives prices at 43 cities, 28 of which are included in the table herewith. Boston, New York, Philadelphia, Chicago and San Francisco are among the places not listed in the Bureau's report for Aug. 1.

Item No.	Commodity. Size and condition.	Unit.	Haverhill, Mass.	New London, Conn.	Poughkeepsie, N. Y.	Rochester, N. Y.	Buffalo, N. Y.	Baltimore, Md.	Richmond, Va.	Columbia, S. C.	Savannah, Ga.	New Orleans, La.
1.	Common brick	1,000	$26.00	$32.00	$20.00	$17.75	$23.00	$20.00	$19.00	$13.00	$17.50	$17.75
2.	Portland cement, excl. of containers	Bbl.	3.20	3.20	3.30	3.35	3.08	3.25	3.50	4.00	3.85	3.20
3a.	Yellow pine, No. 1, dimension 2x4—16′, S1S1E	M	60.00	60.00	.....	48.00	55.00	40.00	32.00	.....	30.00	45.00
3b.	Douglas fir, No. 1, dimension 2x4—16′, S1S1E	M	.....	.....	47.00	56.00	60.00	.....	.....	.....	.....	.....
3c.	N. Carolina pine, No. 1, dimension 2x4—16′, S1S1E	M	.....	.....	.....	48.00	.....	.....	.....	25.00	.....	.....
4.	Common boards, No. 1, 1x6	M	46.00	45.00	47.00	45.00	50.00	.....	32.00	30.00	30.00	48.00
5a.	Y. P. flooring edge, grain "C," 1x4—10′—16′	M	100.00	110.00	.....	130.00	85.00	.....	70.00	110.00	50.00	53.00
5b.	Douglas fir V. G., No. 2, 1x4—10′—16′	M	.....	.....	.....	.....	115.00	.....	.....	.....	.....	.....
6a.	Red cedar shingles, extra clear, 16″, 5 to 2	100 sq. ft.	6.50	7.50	.....	6.25	6.75	11.20	7.20	.....	.....	.....
6b.	Cypress shingles, extra clear, 16″, 5 to 2	100 sq. ft.	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.25
6c.	Composition shingles, crushed slate surfaced	100 sq. ft.	7.50	7.25	.....	.....	.....	6.00	5.48	6.50	6.50	.....
7.	Gypsum plaster board, ⅜″	1,000 sq. ft.	40.00	50.00	50.00	30.00	45.00	32.50	40.00	37.00	40.00	45.00
8.	Lime, HYD, com	Ton	24.00	.....	24.00	20.00	16.00	17.50	17.50	20.00	22.50	22.00
9.	Building sand	Cu. Yd.	2.60	1.50	2.50	2.25	1.28	2.50	.....	1.00	2.25	2.00
10.	Crushed stone, ¾″	Ton	3.50	3.00	3.25	2.25	1.80	.....	.....	2.75	5.25	.....
11.	Wire nails	Keg	5.25	5.05	5.25	4.25	4.25	4.00	4.05	4.25	4.05	4.00
12.	Window glass, single A, 10″x12″	50 sq. ft.	.....	.....	.....	4.20	4.20	4.00	.....	.....	.....	4.50
13.	Hollow tile, 8″x12″x12″	Each	.30	.....	.23	.21	.21	.24	.20	.19	.....	.24
14.	Cast iron soil pipe, 4″ E. H., 13 lbs. per ft	Ton	.....	.....	.....	66.25	63.05	74.34	.....	.....	.....	81.32
15.	Steel pipe, 1″ galv	100 ft.	.....	.....	.....	10.52	10.00	10.10	.....	11.89	8.46	.....
16.	Reinforcement bars, ¾″ square	100 lbs.	4.75	.....	5.00	3.60	.....	3.50	3.35	4.50	5.00	3.75
17.	Structural steel, fab. 6″ I beams	100 lbs.	5.50	.....	5.50	4.50	.....	3.50	4.50	5.00	5.00	3.90
18.	White lead, dry	100 lbs.	.....	17.00	.....	12.60	14.00	.....	.....	14.75	14.00	16.75
19.	Zinc oxide, Am. process lead free	100 lbs.	.....	.....	.....	.....	.....	.....	.....	20.00	20.00	18.00
20.	Gypsum plaster, neat	Ton	24.00	.....	.....	18.00	17.00	20.00	19.50	20.00	20.00	18.00
21.	Linseed oil, raw, in bbls	Gal.	1.25	.....	.....	1.22	1.25	1.13	1.12	1.50	1.35	1.01
22.	Roofing slate, No. 1 ribbon	100 sq. ft.	.....	.....	.....	15.00	.....	.....	.....	.....	.....	16.00
23.	Tar paper, roofing, 2-ply, 75 lbs. per roll of	100 sq. ft.	.....	.....	.....	1.80	2.00	3.75	.....	.....	.....	3.00
24.	Rosin sized sheathing, 3-ply, 30 lbs. per roll of	500 sq. ft.	1.60	1.60	1.75	1.50	1.50	1.45	.....	.....	1.00	1.30

	Shreveport, La.	Pittsburgh, Pa.	Cleveland, Ohio	Dayton, Ohio	Detroit, Mich.	Bay City, Mich.	Milwaukee, Wis.	Waterloo, Iowa	Council Bluffs, Iowa	Des Moines, Iowa	Kansas City, Mo.	Grand Forks, N. D.	Sioux Falls, S. D.	San Antonio, Tex.	Tucson, Ariz.	Sacramento, Cal.	Portland, Ore.
1.	$15.00	$18.00	$16.00	$18.00	$17.50	$15.65	$13.75	$16.50	$16.00	$19.00	$16.50	$15.00	$18.00	$17.00	$15.00	$17.00	$20.00
2.	3.20	3.10	3.48	3.60	3.72	2.75	2.80	3.00	3.00	3.40	2.90	3.20	3.20	3.60	4.40	3.45	3.35
3a.	46.00	51.00	58.00	57.50	45.00	50.00	44.00	52.00	50.00	52.00	54.00	.....	.....	57.00	.....	.....	.....
3b.	.....	.....	.....	57.50	.....	.....	.....	50.00	48.00	52.00	54.00	52.00	51.50	.....	65.00	44.00	24.00
3c.	.....	.....	.....	52.50	45.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4.	50.00	48.00	50.00	70.00	45.00	48.00	39.00	46.00	48.00	60.00	60.00	50.00	46.00	66.00	62.50	44.50	24.00
5a.	100.00	78.00	100.00	.....	.....	80.00	.....	95.00	100.00	105.00	95.00	.....	.....	120.00	.....	.....	.....
5b.	.....	.....	.....	90.00	.....	.....	.....	95.00	95.00	95.00	95.00	95.00	87.00	.....	100.00	83.50	58.00
6a.	7.20	6.50	6.00	6.20	7.00	7.00	6.50	6.50	6.80	7.50	6.50	6.75	5.80	6.80	.....	5.15	.....
6b.	7.20	.....	.....	6.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.00	.....	.....
6c.	7.70	.....	6.25	6.50	7.25	6.50	7.25	7.50	.....	6.20	6.00	.....	7.50	9.00	.....	.....	.....
7.	45.00	37.50	32.00	50.00	30.00	40.00	37.50	36.00	.....	46.80	32.50	60.00	32.00	58.00	.....	41.50	38.50
8.	25.00	23.00	18.00	15.20	20.00	18.00	18.00	20.00	.....	21.20	18.50	.....	24.00	18.00	23.00	34.40	26.00
9.	2.25	2.50	2.50	2.00	2.75	2.50	2.20	1.75	3.50	2.00	.....	3.00	1.50	2.25	1.15	1.50	2.60
10.	5.40	6.00	3.50	2.00	2.50	3.75	3.60	3.50	5.00	4.50	2.25	.....	.....	2.00	3.50	2.75	.....
11.	4.60	3.50	.....	3.90	4.25	3.60	4.50	4.50	.....	4.25	.....	5.50	5.00	6.20	6.25	.....	4.50
12.	.....	4.80	.....	4.50	.....	5.20	5.40	5.25	.....	4.80	4.50	.....	.....	4.80	.....	4.67	5.00
13.	.22	.21	.....	.21	.20	.18	.18	.17	.14	.....	.17	.....	.19	.23	.18	.....	.20
14.	106.26	.....	.....	.....	.....	83.50	95.00	82.00	.....	.....	.....	106.26	.....	116.00	.....	78.80	112.42
15.	11.95	9.86	.....	10.57	.....	9.25	10.50	12.00	.....	11.25	11.20	.....	.....	11.12	15.00	12.05	14.20
16.	4.00	4.00	.....	3.25	6.00	4.50	5.75	4.00	3.40	3.35	3.25	.....	.....	4.25	5.25	4.25	4.00
17.	6.50	3.25	.....	3.25	6.00	4.50	5.75	4.95	4.50	5.00	4.00	.....	.....	4.50	.....	4.50	5.50
18.	15.00	14.00	14.00	14.50	14.00	13.00	14.50	14.50	15.00	14.50	14.13	.....	.....	15.00	15.25	12.50	13.25
19.	.....	16.80	.....	15.00	.....	18.00	.....	19.00	.....	.....	.....	.....	.....	16.00	.....	17.50	20.00
20.	24.00	22.00	.....	18.00	.....	17.50	18.00	18.00	18.00	18.00	18.00	.....	20.00	24.00	21.00	.....	24.00
21.	1.13	1.00	1.12	1.20	1.06	1.15	1.25	1.30	1.30	1.25	1.15	2.00	.....	1.35	1.46	1.18	1.24
22.	12.00	13.50	.....	15.00	.....	17.25	18.00	18.00	.....	18.00	.....	.....	.....	18.00	.....	.....	30.00
23.	1.75	1.95	2.50	.....	2.10	2.75	2.85	3.25	3.30	2.65	2.60	3.00	2.70	3.50	2.90	.....	2.00
24.	1.40	1.35	.90	.....	1.40	1.10	1.25	1.50	1.50	1.50	.....	2.00	1.50	2.25	1.75	.....	1.80

Pittsburgh Steel and Iron Prices

The following data on prices and freight rates are taken from The Iron Age of Sept. 13:

Plates, sheared, tank quality, base, per lb.	2.50c
Beams, channels, etc., base, per lb.	2.50c
Soft steel bars, base, per lb.	2.40c
Reinforcing steel bars, base, per lb.	2.40c
Track spikes, 9/16 in. and larger, base, per 100 lbs.	$3.15
Track spikes, ½ in. and smaller base, per 100 lbs.	3.15-3.50
Spikes, boat and barge, base, per 100 lbs.	3.50-3.75
Track bolts, ¾-in. and larger, base, per 100 lbs.	4.00-4.25
Tie plates, per 100 lbs.	2.55-2.60
Angle bars, base, per 100 lbs.	2.75
Butt welded steel pipe, ¾-in.—Percentage discount—Black 60; galv.	48½
Butt welded steel pipe, 1 to 3 in.—Percentage discount—Black 62; galv.	50½
Lap welded steel pipe, 2½ to 4 in.—Percentage discount—Black 57; galv.	46½
Pig iron, No. 2X, Philadelphia, per gross ton	$26.26
O.h. rails, heavy, at mill, per gross ton	43.00

Freight Rates

All rail freight rates from Pittsburgh on domestic shipments of finished iron and steel products, in carload lots, to points named, per 100 lbs., are as follows:

Philadelphia	$0.32	St. Louis	0.43
Baltimore	0.31	Kansas City (pipe)	$0.705
New York	0.34	St. Paul	0.60
Boston	0.365	Omaha	0.735
Buffalo	0.265	Omaha (pipe)	0.705
Cleveland	0.215	Denver	1.27
Cleveland, Youngstown, comb.	0.19	Denver (pipe)	1.215
Detroit	0.29	Pacific Coast	1.34
Cincinnati	0.29	Pac. Coast, ship plates	1.20
Indianapolis	0.31	Birmingham	0.58
Chicago	0.34	Memphis	0.56
		Jacksonville, rail and water	0.415

Index Numbers of Wholesale Prices

An "index number" is really a percentage, and in the case of an "index price" shows the relative price level at different times. In the accompanying table the price level, or "index price," is 100 for the year 1913; and the indexes for other periods are those calculated by the U. S. Department of Labor.

In previous issues it has been stated that the index of building materials did not include steel. This is in error, as the revised index is a weighted average of the principal building materials including steel and certain other metals. All figures given in this table are in accordance with the revised calculation.

	Farm products.	Foods.	Cloths and clothing.	Fuel and lighting.	Metal and metal products.	Building materials.	Chemicals and drugs.	House furnishing g'ds.	Miscellaneous.	All commodities.
1913	100	100	100	100	100	100	100	100	100	100
1914	103	102	98	93	85	92	101	100	95	98
1915	104	105	98	88	98	94	134	100	95	101
January	104	106	94	87	82	88	108	99	99	98
July	104	104	96	81	106	94	130	100	94	100
October	106	102	101	94	105	98	151	100	93	102
1916	123	121	127	126	162	120	181	106	121	127
January	110	109	110	113	133	110	84	103	110	113
April	113	114	118	120	164	120	200	104	110	121
July	117	117	125	121	158	120	175	107	120	123
October	136	134	137	128	164	124	164	109	132	136
1917	190	167	175	169	231	157	202	125	148	177
January	152	149	158	171	198	138	173	118	149	153
April	184	164	164	164	230	155	186	121	153	173
July	196	169	181	176	292	168	205	129	153	188
October	207	180	185	153	207	156	231	139	142	183
1918	218	188	228	170	187	172	215	153	156	194
January	211	182	201	164	183	161	223	137	145	184
April	213	181	220	166	184	169	228	144	152	190
July	217	185	238	175	189	177	209	159	159	196
October	225	198	245	176	192	177	211	164	163	202
1919	231	207	253	181	162	201	169	184	175	206
January	224	203	220	178	175	176	181	167	166	199
April	230	205	205	177	153	169	160	167	160	199
July	241	210	262	181	160	209	167	183	177	212
October	227	205	291	189	162	229	173	194	187	211
1920	218	220	295	241	192	264	200	254	196	226
January	247	231	339	194	175	274	189	239	194	233
April	243	238	336	231	203	300	210	242	206	245
July	233	238	300	259	202	269	212	275	203	241
October	187	201	245	280	191	240	198	271	188	211
1921	124	144	180	199	129	165	136	195	128	147
January	143	162	196	247	153	192	153	217	154	170
March	127	151	183	212	140	173	143	216	139	155
April	117	144	176	205	138	167	135	216	130	148
May	118	139	173	200	138	165	134	209	126	145
June	114	137	172	191	133	163	133	196	125	142
July	119	141	172	186	124	160	129	180	123	141
August	123	146	171	184	117	156	129	179	119	142
September	124	142	178	181	116	156	131	179	118	141
October	124	140	180	189	116	159	131	180	118	142
November	121	139	180	197	114	163	129	178	119	141
December	120	136	180	199	113	158	127	178	121	140
1922	133	139	180	220	122	169	124	176	117	149
January	122	131	176	196	112	157	124	178	117	138
February	131	135	174	191	110	156	123	177	117	141
March	130	137	172	191	109	155	125	175	117	142
April	129	137	171	194	113	156	124	175	116	143
May	132	138	175	216	119	160	122	176	116	148
June	131	140	179	225	120	167	122	176	114	150
July	135	142	180	254	121	170	121	173	114	155
August	131	138	181	271	126	172	122	173	115	155
September	133	138	183	244	134	180	124	173	116	153
October	138	140	188	226	135	183	124	176	120	154
November	143	143	192	218	133	185	127	179	122	156
December	145	144	194	216	131	185	130	182	122	156
1923—										
January	143	141	196	218	133	188	131	184	124	156
February	142	141	199	212	139	192	132	184	126	157
March	143	143	201	206	149	198	135	185	127	159
April	141	144	205	200	154	204	136	187	126	159
May	139	144	201	190	152	202	134	187	125	156
June	138	142	198	186	148	194	131	187	123	153
July	135	141	193	183	145	190	128	187	121	151
August	139	142	193	178	145	186	127	183	120	150

Hauling 67-Ton Girders

Two of the largest girders ever hauled into Chicago's downtown district were delivered at The Straus Building, Sunday, Sept. 9. These girders each weigh 67.85 tons, are 55 ft. long and stand 11½ ft. high. It took practically all day to unload the girders, carry them about ½ mile and unload them at The Straus Building, Michigan Ave. at Jackson Blvd.

used, but in handling the Straus girders two 40 hp. tractors proved sufficient.

Forty-two tons were carried on the rear trailer and 25 tons on the tractor. The load was distributed over ten wheels which included the front wheels of the first tractor.

Girders of such size are necessary because they not only carry their load of the building but they must carry

Railroad Wrecker Being Used to Unload One of the Two 67.85 Ton Girders.

Because of the immense size it was necessary to have a Chicago, Milwaukee & St. Paul Ry. wrecker, with a 150-ton capacity, load the girders on flat cars at the Goose Island yard. The cars were taken to the Michigan Central team track at South Water St. and Michigan Ave., where an Illinois Central Ry. wrecker unloaded them individually on a combination tractor and four wheel bearing special trailer, equipped with two separate axles.

Formerly in order to handle girders of such size 50 to 75 horses were

the center load of the 10-story tower which tops the 22 stories of the main shaft of the building. The girders are to be placed between the 5th and 6th floors.

The only larger girder ever delivered in Chicago, according to J. X. Galvin, general manager of the Pennoyer Merchants Transfer Co., was a 70-ton girder used in the Stevens Building. Two girders of 62.9 tons were used in the structural work of the Chicago Theatre.

To avoid traffic congestion the girders were hauled on Sunday.

Production of High Class Office Space

How Character of Rented Space in Buildings Is Affected by Architectural Design Outlined in Paper Presented at Convention of National Association of Building Owners and Managers

By JOHN MEAD HOWELLS

During my 25 years of practice of architecture, largely in the design and construction of office buildings, this question of "How much the architectural design affects the character of the rental space produced?" has constantly been before the owners, the managers and myself, with varying answers.

What Is Meant by Architectural Design?—Many people not experienced in building seem to think that architectural design means ornament applied to the exterior of a building. In fact, some weeks ago, I talked with the president of an insurance company, who said, "My idea of a building is to build it correctly from the inside point of view and then let the architect dress up the outside artistically." But if this is his idea, he might better dispense with the architect entirely. Good architectural design beings at the foundations, not on the outside of the building. By architectural design, I mean the character and effect of the entrances and vestibules, the disposition of elevators and elevator halls, the access from the elevators to the offices, the position and depth of the office space with regard to the windows, and last but not least, the dignity and character of the exterior of the building.

It is generally conceded that the best office space must be only a certain distance from the windows, and the ceiling, height and position of the windows in the wall must be such as to give the deepest angle of lighting; but what must be considered the ideal story height for office space? And is there a limit to the ceiling height? You know that in most American cities, the zoning and building laws are arranged to take a number of stories of a certain ceiling height within the zoning limit, and if you leave out one story to gain extra ceiling height, in the other stories that costs rental space, and rental space is income.

Interesting Example in New Tribune Building.—In the new building for the Chicago Tribune, the subject of a recent architectural competition, Raymond M. Hood and I had an interesting example. Our orders were to produce the finest office space on the market. In the floor plans, we placed the elevators, stairs, toilets, and other services in the center of the plan, with uninterrupted office space all around, and windows all around the outside of the office space. But the first plans showed a row of steel columns all around the middle of this office space.

On our own responsibility we made another set of plans, showing this office space in one span, clear of columns and without ceiling beams. This meant more money, and a good deal of it, because special beam sections and more steel had to be used.

But Mr. Onderdonk, the manager of the various Tribune properties, looked at it only once. "Do it," he said, "that will be the finest space in town, and I can ask a large percentage higher rent, and get it."

In the same Tribune building, it has been decided to build permanent handsome cloistered halls for the elevators on each floor. Also, and this is sometimes more of a disputed question, it has been decided to make the entrance on Michigan Ave. deep and high, and the main lobby leading to the elevators, lofty and dignified, but moderate in size, and not so large in proportion as certain New York buildings like the Singer Building or the City Investment Building.

The Importance of the Entrance.—The excuse for taking this space, and the idea of it is that this space belongs to every tenant in the building, and is an asset to every tenant. Also, a visitor, after approaching a handsome building from the outside, should not get a cramped or undignified impression on entering.

Imagine two identical buildings side by side on a principal street like Broadway. One of them has a high, dignified, airy entrance lobby with space to look about, and with the elevators on one side of a wide space. Imagine the second building like the

first in every particular, except that the ground floor space forming the ample entrance and lobby in the first, has been used as a rental space in the second, leaving a comparatively cramped corridor entrance, with ordinary ceiling height. This entrance, like all such corridor entrances, brings you to the elevators sideways. This way of approaching a line of elevators is a usual way and, on a narrow lot, it is often necessary, but if the corridor is narrow, you have to pass in front of three cars to get to the fourth, or in front of five cars to get to the sixth.

Now, as to this second building, with its ungenerous entrance and its ecenomoical lobby, there is perhaps nothing practical that can be argued against it—the entrance is there; you can get in and out without hitting your head; and you can reach the elevators all right. But, after ten years, will it hold its own against the other similar building, with the other's dignified entrance and liberal lobbies? I think not. The space thus taken on the ground floor for dignified entrance and ample lobby, is regarded as capitalized for the benefit of the rental floors above, and for every tenant in them.

The Exterior Material.—Another definite tendency in the finest buildings today, is the exterior material. The beauty of the material is being considered more, and the decoration less, and this is one reason why Chicago is turning to cut stone as against other outside materials. On the handsomest exteriors, decoration and ornament and cornices and belt courses are being eliminated, and the beauty of native stones in plain surfaces is taking their place.

You must have all noticed how the newest designs in the best high buildings are without the great overhanging carved cornices of ten years ago. The designs submitted in the recent Chicago Tribune competition show this clearly. All the three designs taking prizes are entirely without cornices, and depend for beauty on the shape of their tops against the sky. This is the whole tendency of the design of tall buildings today; to produce a building that has a top to end it, and is not sawed off flat, as they used to be. Every office building today that has isolation for light and air protection on more than two sides should be designed with a dignified top of some sort, to give it a finish against the sky. This tendency to design buildings with well-shaped tops is being helped along by the zoning setbacks in some cities. Also the doing away with cornices on both sides of the street opens the street to that much more sun and air.

The Permanent Value of Good Architectural Design.—Do not all these questions of architectural design give or take away permanent value? Can a badly designed building compete with a similar building well designed? Will the building erected on a badly worked out plan, stand up in value and rentals against the neighbor which is well designed? A well designed building built from plans worked out by an experienced architect in conjunction with the owner, has the advantage of the architect's experience as an expert.

I realize that some people do not think the services of an expert necessary. The mayor of one of our great cities, on taking office for his first term, announced to a delegation of architects and engineers who waited on him, that he "had no use for experts." In this matter, he was of exactly the same opinion as a certain man whose wife was taken with appendicitis, a complicated case, but, this man also did not believe in "trained experts," so he had his wife operated on by a journeyman plumber. The result was not satisfactory.

If you could build cheaper on a poor plan than on a good one, there would be every excuse for doing so, but you can't. It costs just as much to erect stone and brick and mortar on a poorly designed plan as on a well arranged one, if the quantities of materials are the same. So probably, after all, the best designed plans are the most desirable.

Workingmen's Compensation in New York State.—Figures made public by the State Industrial Commissioner of New York show that during the nine years since the Workmen's Compensation Law took effect, payments of $125,000,000 have been made to more than 400,000 claimants for compensation under the law. The aggregate annual payments have averaged approximately $13,000,000.

Crib Dams on the Cumberland River

Methods and Cost of Construction Given in The Military Enginee

By J. R. SLATTERY
Lieutenant-Colonel, Corps of Engineers

During the last season a crib dam 450 ft. long was constructed at Lock E, Cumberland River. The general design of the dam is shown on the accompanying illustration.

A trench was first excavated in the bed of the river, so as to provide a level bed for the entire width of the river on which to base the dam. It was expected that this material would consist of a fairly loose gravel, but it was found to consist partly of that and principally of cemented gravel, which it was practically impossible to handle except with a dipper dredge. Considerable time was lost and unnecessary expense incurred as a result of the delays incident to replacing the derrick boats equipped with clamshell buckets (which proved unable to handle this material) with a dipper dredge. It was necessary to wait for a rise in the river before a dipper dredge could be gotten to the work.

A total of 8,899 cy. yd. of material was dredged in preparing this trench. Part of the material was simply thrown to one side, and part of it was placed on decked barges, which were towed some distance downstream, where the material was removed by means of a derrick boat operating a clam-shell bucket. The cost of this excavation amounted to 38½ ct. per cubic yard. The detailed analysis of this cost is shown in Table I.

Details of Construction.—Long leaf yellow pine and Douglas fir timber were used in constructing the cribs (341,402 ft. b. m. of the former and 356,389 ft. b. m. of the latter). The average price of this timber was $49.83 per 1,000 ft. b. m., delivered at Kuttawa, Ky., some 25 miles below the site of the dam, the nearest point at which railroad tracks come close to the river. From this point the timber was placed on decked barge and towed to Lock E, where it wa unloaded on the bank, part bein placed near the upstream end of th lock within reach of a derrick with 90-ft. boom, and the balance in a yar a short distance below the lock, fror which yard it was hauled to the der rick by narrow gauge railroad.

This derrick handled the timber from the bank to hinged ways buil on a barge. The cribs were 30 f x 48 ft. 9 in., with pens approxi mately 10 ft. x 10 ft. The cribs wer first built up to a height of six tim bers; then one end of the hinged way was lifted by a derrick, causing th crib to slide into the water. The crib were then towed into position an sunk by laying on them steel shee piles, to be driven later immediatel upstream from the dam to cut off th flow of water underneath it. Th cribs were carefully lined up by tran sit on the shore and were adjuste and held in proper vertical positio by being secured to 3x12 in, upright resting on the bottom. As soon a the cribs were correctly aligned an leved, sufficient one-man stone wa placed in the pens to hold the par tially completed cribs securely in po sition. The cribs were then built u pens were filled, except three in eac to the height of the apron and all th crib which were left open in order t care for the flow of the river. Th decking of the apron was then place and the sheet piling driven along th upper side of the dam. The first cri was placed near the center of th stream, the excavation of the trenc immediately adjoining the abutmen not having been completed.

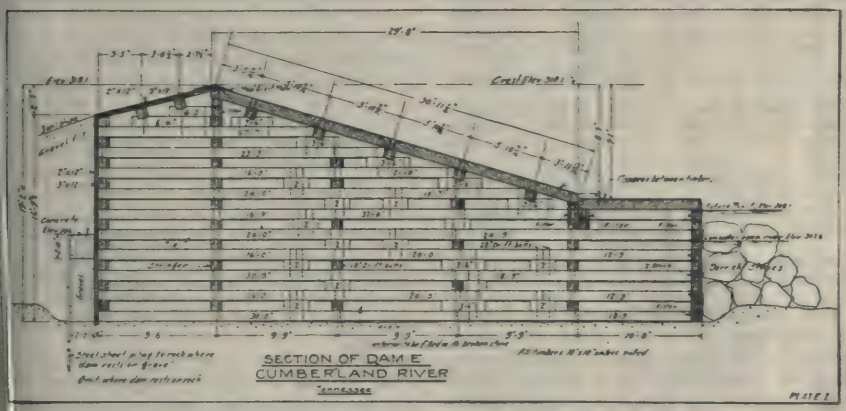
From this crib, others were place in each direction, until the dam wa completed to the height of the apro

Table I—Analysis of Cost of Dredging

	Superintendence	Man Days	Labor	Plant Supplies	Plant Depreciation	General Expense	Total	Unit Cos (Per Cu. Yd
Loosening and loading	$80.60	306	$1,114.70	$924.02	$273.57	$382.31	$2,725.20	$0.30
Towing to dump	.14	.....	2.71	558.89	25.60	10.87	598.31	.06
Dumping	2.10	.....	73.63	.....	.....	25.48	101.21	.01
Total	$82.84	.....	$1,191.04	$1,483.01	$299.17	$418.66	$3,424.72	.....
Unit cost	.004	.....	.184	.166	.033	.047	.....	.38

from the abutment to within about 150 ft. of the lock. This gap was left open to care for the flow of the river in case the completion of the dam should be prevented by high water. Work was then started immediately next to the abutment, bringing the cribs to full height and filling all of the pens, except three in each crib left open to care for the flow of the river. When this work had progressed to such a point that it was reasonably certain the remainder of the dam could be placed within two weeks, cribs were placed closing the gap and work was started placing the decking and sheathing, starting from the abutment side.

Completing the Dam.—The final



Section of Crib Dam on the Cumberland River.

tep was to fill the pens left open and place the decking and sheathing over nd above these pens. Derrick stone as placed along the toe of the dam s soon as possible after cribs were unk and completed to the height of e apron. After the completion of e dam, additional derrick stone was laced below that previously placed nd along the abutment. The rock sed for filling the cribs and for protecting the toe of the dam and abutment was excavated from the lock pit d stored on the bank just below the ock. When needed for filling the ibs it was loaded by hand into skips. hese were lifted by means of a derrick into dump cars, which were then n down a track along the river bank nd dumped on decked barges. A mall quantity of the rock was loaded directly into dump cars by means of a Thew shovel, and a small quantity was obtained from loose rock in a quarry a short distance below the site of the lock. The low cost of rock used in filling was due to the fact that the balance of the cost of excavating it was charged as excavation against the lock proper. The loaded barges weer towed to the dam, a distance of only about 200 yd. The rock was then loaded by hand into skips, which were picked up by three derrick boats and dumped into the pens.

In order to drive the steel sheet piling, a standard gauge track was built across the dam when it had been completed to the height of the apron, and a traveling pile driver, mounted on the trucks and equipped with a steam hammer, was used in driving the steel sheet piling.

It is thought that the method of handling the rock for use in this dam was excessive. In building the dam at Lock F, it is proposed to quarry the necessary rock during the winter months and store it on the bank immediately above the abutment. From this storage pile a track will be run down the bank and out over the dam. The track will probably first be placed on the dam when it is completed to about the height of the apron, and then will be laid again nearly at the height of the coaming when work is started, bringing the dam to full height. Rock will be loaded from the storage pile into dump cars by means of a locomotive crane equipped with

an orange-peel or special heavy bucket. It is hoped that it may be possible by using this equipment to avoid the expense of loading the rock into skips by hand. The cars will be run out on the track and the rock thus dumped directly into the pens. By laying the track twice, as contemplated, all but a small quantity of rock will be dumped directly into its final resting place.

Cost of Construction.—The cost of constructing the dam was as follows:

	Labor	Materials	Total
Handling timber from yard to dam	$1,939.08	$39.63	$3,750.50
Building crib	7,728.62	42,259.65	53,194.00
Loading and towing rock	8,304.10	17.69	15,743.31
Filling cribs and placing toe stone....	5,961.85	6,299.00	15,400.98
Handling piles	135.59	.....	165.25
Driving piles	382.46	6,203.94	6,833.37
Concrete	168.70	312.61	598.32
Total	$25,539.70	$55,132.52	$97,050.68

The total includes, besides labor and materials, the following: Superintendence, plant supplies, plant depreciation and general expense.

Cost of preparation of bed of river for dam	$3,424.72
Cost of dam proper.....	97,050.68
Overhead	4,738.40
Grand total	$105,213.80
Estimated cost	$130,000.00

The total time consumed in building the dam after the first crib was placed was about eight weeks. On most of the jobs, two shifts were used, and toward the last, when water was expected almost daily, many men were worked considerably overtime.

Labor was paid from $2 to $2.75 per day and subsistence, with a few specially skilled men receiving as high as $3.50 per day and subsistence. Carpenters were paid from $4 to $5 per day and subsistence. Hoisting engineers were paid from $100 to $110 per month and subsistence.

Working Stresses for Structural Timbers

Technical Note, Forest Products Laboratory, U. S. Forest Service

The working stresses for structural timbers of various species given here are the result of a long series of tests by the Forest Products Laboratory at Madison, Wis., on small clear specimens and timbers containing defect They are applicable to beams, joist girders and short columns graded i accordance with the Forest Servic basic grading rules for structur timbers. (See Forest Products Lab oratory Technical Note 200.) Com mercial grading rules were found i general to be too indefinite in the limitations of the size, number ar location of defects to make it pra tical to establish working stresses fo them, even if tests could be carrie out on every grade found in the loc markets.

The stresses given in the table ar for timbers of the Forest Service bas grade, Select (S2). From them th stresses permissible for the othe three basic grades can be easily com puted. With Extra Select (S1) tim bers of any species a stress 7/6 a large as the stress given in the tab may be used. Standard (S3) timber should be subjected to only 5/6 th listed stress. Common (S4) timber can take only 4/6 the stress given fo Select (S2). The working stresses o the different grades of Douglas f and southern yellow pine can be in creased one-sixth the allowable stres given in the table for the basic o Select (S2) grade, if the materi meets the density requirements of th American Society of Testing Ma terials.

A "factor of safety" adjustment o the test values has been made to tak care of the loss in strength from de fects, the effect of long continue loads, the variation of individu pieces from the average, and the po sibility of slight accidental overloa ing. It is evident that a large pa of this "factor of safety" is require to correlate laboratory test resul with actual conditions of use, an only a small part of it may be con sidered a true factor of safety. Th application of a load which would pro duce three times the working stres given as allowable would be expecte to cause the immediate failure o some of the timbers and the ultimat failure of 75 per cent of them. I fact, the application of loads whic would produce stresses only one an one-half times the working stresse recommended would be expected t cause occasional failures if the load were left on for any great length o time.

WORKING STRESSES PERMISSIBLE FOR STRUCTURAL TIMBERS OF SELECT (S2) GRADE[1]

(Pounds per square inch)

Species	Bending					Compression					
	Allowable stress in extreme fiber for Select (S2) grade			Allowable horizontal shear stress Select (S2) grade All locations	Allowable modulus of elasticity for all grades All locations	Allowable stress parallel to grain Short Columns[2] for Select (S2) grade			Allowable stress perpendicular to grain for all grades		
	Damp or wet location (docks, piling, and sills)	Outside, not in contact with soil (bridges and open sheds)	Under shelter in dry location (factories and warehouses)			Wet location	Dry outside location	Dry inside location	Wet location	Dry outside location	Dry inside location
Ash, black	800	900	1000	90	1,100,000	800	880	880	150	200	300
Ash, commercial white (green, biltmore, white)	1000	1200	1400	125	1,600,000	900	1000	1100	200	275	300
Aspen and largetooth aspen	500	650	800	60	900,000	450	550	700	100	125	150
Basswood	600	800	800	80	900,000	450	650	700	100	125	150
Beech	1000	1500	1800	125	1,600,000	900	1100	1200	200	275	300
Birch, paper	600	750	900	80	1,000,000	450	550	650	100	150	200
Birch, yellow and sweet	1000	1300	1600	120	1,600,000	900	1100	1200	200	275	300
Cedar, Alaska	800	900	1000	90	1,100,000	650	750	800	150	200	250
Cedar, western red	750	800	900	80	1,000,000	650	700	700	125	150	200
Cedar, northern and southern white	600	650	750	70	800,000	450	500	550	100	140	175
Cedar, Port Orford	900	1000	1100	100	1,200,000	750	825	900	150	200	250
Chestnut	700	850	950	90	1,000,000	600	700	800	150	200	300
Cottonwood, common and black	500	650	800	60	900,000	450	650	700	100	125	150
Cypress, bald	900	1100	1300	100	1,400,000	800	1000	1100	225	250	350
Douglas fir (western Washington and Oregon)[3]	1000	1300	1500	90	1,600,000	950	1000	1100	200	225	325
Douglas fir (Rocky Mountain type)	700	900	1100	85	1,200,000	700	800	800	200	225	275
Elm, cork	1000	1300	1500	125	1,200,000	900	1100	1200	200	275	300
Elm, slippery and white	800	900	1100	100	1,200,000	650	750	800	125	175	250
Fir, balsam	650	750	900	70	1,000,000	500	600	700	100	125	150
Fir, commercial white (white, noble, grand)	750	900	1100	70	1,100,000	650	750	800	150	200	300
Gum, black and cotton	800	900	1100	100	1,200,000	650	750	800	150	200	300
Gum, red	900	900	1100	100	1,200,000	650	750	800	150	200	300
Hemlock, western	900	1100	1300	75	1,400,000	800	900	900	100	225	300
Hemlock, (eastern)	600	900	1000	70	1,100,000	600	700	700	100	225	300
Hickory, (true and pecan)	1200	1500	1900	140	1,600,000	1000	1200	1200	250	400	600
Larch, western	900	1100	1300	100	1,300,000	850	1000	1100	200	275	325
Maple, sugar and black	1000	1300	1500	150	1,600,000	900	1100	1200	200	275	300
Maple, red and silver	750	900	1000	100	1,100,000	600	700	800	200	250	350
Oak, commercial red and white	1000	1200	1400	125	1,200,000	800	900	1000	200	275	300
Pine, southern yellow[4]	1000	1300	1600	110	1,600,000	850	1000	1100	200	225	325
Pine, white, sugar, western white, western yellow	750	800	900	85	1,000,000	650	750	750	125	150	250
Pine, Norway	800	1000	1100	65	1,200,000	700	800	800	150	175	300
Poplar, yellow	800	900	1000	80	1,100,000	600	700	800	125	150	250
Redwood	800	1000	1200	70	1,200,000	750	900	1000	125	150	250
Spruce, red, white, Sitka	600	900	1100	85	1,200,000	650	750	800	125	150	200
Spruce, Engelmann	500	650	750	70	800,000	450	550	600	100	140	175
Sycamore	800	900	1100	60	1,200,000	650	750	800	150	200	300
Tamarack, (eastern)	900	1100	1200	95	1,300,000	800	900	1000	150	225	300

1 Working stresses for Extra Select (S4), Extra Select (S3) Dense, Standard (S3), and Common (S4) grades are obtained by multiplying the basic stress by 7/8, 6/8, 5/8, and 4/8 respectively.

2 The influence of knots on compressive strength of columns of constant cross section decreases as the length increases. When the length reaches 30 times the least dimension, knots such as are allowable in Select (S2) timbers have no effect on the strength as a column.

3 The working stresses of any grade of timbers of Douglas fir and southern yellow pine which meet the density requirements of the American Society of Testing Materials shall be increased one-sixth the allowable stress given in the table for the basic or Select (S2) grade.

Some Fundamental Purposes and Limitations in Zoning

Extract from Report Outlining a Tentative Zoning Plan for Providence, R. I.

By ROBERT WHITTEN

Congestion is one of the most vital and difficult problems confronting cities at the present time—street congestion, transit congestion, land overcrowding and the congestion of population. Zoning can make a very great contribution to the reduction or prevention of these congestion evils. In the first place, zoning and regional planning can do much to lessen the increasing concentration of business and industry in the central part of the city. This concentration means increased traffic, transit and housing congestion. A movement toward the decentralization of business and industry can be furthered by careful zoning. Coincident with the centripetal movement of business and industry toward the center, there is naturally a much smaller centrifugal movement away from the center. The heavier industries naturally move out as land values near the center increase and opportunity for expansion is blocked. But the place of the large plant is usually taken by a number of light manufacturing establishments having several times as many employes as the former plant, thus adding greatly to transit and housing congestion. The spreading out of the industries and the establishment of industrial centers in suburban sections can be promoted by zoning.

Decentralization by Zoning.—Zoning regulations can also promote the development of important sub-centers that will take care of much of the business that would otherwise increase congestion in the central area. Zoning can further decentralization:

(1) By providing in the zoning plan for large business districts around a number of the most important traffic and focal points throughout the city.

(2) By providing for local or suburban industrial centers and for the extension of the industrial areas far out into the suburbs along most of the railroad lines.

(3) By limiting the expansion of the central business and industrial areas, and thus tending to crowd out business and industries that can be more economically and appropriat located away from the main busine traffic and high value center.

(4) By limiting the height of bui ings in the central business and dustrial area. This limits expans vertically and has to a slight deg at least the same effect as the li tation of expansion horizontal above referred to.

The decentralization of busin and industry as above outlined is a essential in order to prevent the c gestion of population in the reside sections adjacent to the central ar Employes working long hours at l wages can afford neither the time the money to live far from their wo In New York City it has been sho that a very large proportion of s employes will live within walking tance of their work, even though t necessitates their living in the m congested and unwholesome quart The movement of industries places of business away from center will make it easier to prev congestion and secure better hous conditions in the residence secti adjacent to the central area.

Zoning and Population Congesti—The problem of congestion of po lation can also be directly attac under a zoning ordinance. In f zoning is the only method yet devi that can be applied to actually p vent the development of over-cro ing in the housing of the populat of a large city. This is accomplis through the area regulations that quire a certain number of square of lot area for each family for wh a tenement is arranged. Without s control there is a continual tende in tenement construction to incre the number of stories and fami and to decrease the size of rooms the number of rooms per fam Congestion breeds congestion. Un a zoning plan, congested conditi already existing in any section of city cannot be helped, but the ext sion of such conditions to other ar can and should be prevented.

The protection of the environm

of the home is another of the fundamental purposes of zoning. This is accomplished through the setting aside of residence districts and prohibiting the intrusion of stores, public garages, steam laundries or other business or industrial uses; by setting aside dwelling house districts from which three-deckers and apartments are excluded; and by maintaing adequate front, rear and side yards and adequate lot sizes in all residence districts.

Conservation of Property Values.—Another of the fundamental purposes of zoning is the conservation of property values; and particularly the prevention of the enormous economic waste in building construction due to the fact that, owing to the invasion of the various sections of the city by inappropriate uses, many buildings become obsolete before they have served one-half their normal life. This economic waste is tremendous. It has been estimated to exceed the loss due to destruction by fire. It is a hazard that must be considered by every investor in real estate, and has undoubtedly increased the rate of return necessary to attract capital for investment. This in turn has meant a lower level for real estate values, the construction of fewer dwellings and apartment houses and higher rents. It follows that zoning by conserving values and reducing the hazard incident to owning real estate will bring a higher general level of values and will tend to reduce rents.

Some Fundamental Limitations in Zoning

Starting with the fundamental premise that the purpose of zoning is the control and direction of building development in accord with a well considered plan for the orderly and harmonious development of all property throughout the city, certain limiting conditions present themselves:

The zoning power is based upon the right of the city to regulate the use of property in the interest of health, safety and general welfare. Only such regulations as can be shown to be reasonable and necessary for these purposes can be enforced under existing constitutional limitations. Judicial interpretation of these limitations exclude for the present at least the adoption of regulations based solely on aesthetic purposes. This rules out many regulations that are proper in private restrictions such as those specifying the cost of a building or regulating its design.

A zoning plan must be reasonable and not arbitrary or confiscatory. Each owner should be permitted a reasonable use of his land. To be reasonable, the use permitted should as a rule be such as will produce a fair return on the actual value of the land. Special care has therefore been exercised in determining districts to place a given area in the class of district that will permit the area as a whole to be devoted to its most profitable use. If there are individual lots within the area that cannot be appropriately improved under the general regulations prescribed for the district, the board of review is authorized to grant such relief as will prevent confiscation and permit a fair return on the actual value of the land even in these exceptional cases. But such relief should be so safeguarded and conditioned that it will not permit an exploitation of the neighborhood or create a nuisance or seriously injure the fair value of neighboring property. To "live and let live" is a good motto to remember in determining what is a reasonable use of property in any particular case.

The above is not an attempt to state legal principles or constitutional limitations in relation to zoning, but rather what seems to be a just and reasonable rule to follow in drafting and applying zoning regulations. To be sure, where public health and safety are vitally and immediately concerned regulations should be applied and enforced, regardless of their effect on the individual property owner. But such cases will be few and far between in a carefully prepared zoning ordinance. Zoning regulations, while they have an undoubted relation to public health, safety and welfare, will as a rule accomplish these purposes more certainly and effectively if they are drawn chiefly with reference to safeguarding the future and with a frank acceptance of existing conditions and existing equities.

Zoning regulations must be applied without discrimination. Areas in different parts of the city which are similarly situated and in which like conditions prevail should be placed in like districts. This principle also precludes partial zoning. The plan should

cover all property throughout the city. It should be city-wide and not piecemeal.

Zoning cannot rebuild a city, but must start with an existing city in which much haphazard and undesirable development has taken place. Zoning regulations are not retroactive; the cannot do away with existing structures or change existing uses. In applying zoning to an already developed area, chief weight must be given to existing conditions and the existing trend of development rather than to conditions previously obtaining, or the ideal development that could have been secured if zoning had been applied earlier. Where intrusions are not serious, however, and the obvious conditions and tendencies indicate that the application of restrictions to a section will stimulate and restore uniformity of development, and benefit the section as a whole, these considerations should prevail over the presence of misplaced and inappropriate uses.

Zoning should aim at a minimum of restriction. Each regulation and each district boundary should be determined with reference to fixing the greatest freedom of action consistent with the public good and the protection of the rights of all owners. In the application of the zoning it is the function of the board of review to vary the strict letter of the ordinance in harmony with its general purpose so as to grant a maximum of freedom while at the same time safeguarding the spirit and purpose of the zoning plan.

Immigration Facts.—According to a report of the National Industrial Conference Board, from July, 1921, to March, 1922, there were 241,644 arrivals and 160,918 departures, making the net immigration 80,726. For the same period a year later the arrivals were 373,511 and the departures dropped to 65,775, making the net immigration for the period 307,736. This occurred in the face of reviving industrial prosperity in Europe. Of the immigrants for the period covered above, only 29,191 were common laborers, the remainder being thus classified: Professional, 9,870; skilled laborers, 65,707; farm laborers, 25,072; miscellaneous, 57,838, and unclassified, 120,058.

Dictionary of Specifications

Work has been started at the U S. Bureau of Standards on the com pilation of material for a dictionar or handbook of specifications for sup plies purchased by federal, state an municipal governments and public in stitutions. This work grew out of meeting held in May, 1923, of Stat Purchasing Agents from all over th country, and at which the co-operatio of the various states was assured i this matter.

On July 11, a conference was hel of various national organizations in terested in the preparation and unifi cation of purchase specifications an in their use from the point of vie of both the producer and the con sumer. This conference was calle for the purpose of organizing an ad visory committee to co-operate wit the Department of Commerce and th National Conference of State Purchas ing Agents in the work of formulatin purchase standards, specifications an tests. Although no meeting of thi advisory committee has yet been hel the various organizations represente are co-operating actively in the actua work of compiling the material fo the dictionary, and a great deal o information has been supplied.

Correspondence conducted with th officers of trade associations and th purchasing agents of a large numbe of municipalities and public institu tions has established the fact tha all the individuals and groups fo which the dictionary of specification is being prepared will welcome it appearance enthusiastically and co operate actively in the preparation.

A collection is now being made o all available specifications prepare by the various departments and inde pendent establishments of the federa government and those used by stat and municipal governments, public in stitutions, and the important nationa trade associations, and technical so cieties. These specifications are be ing thoroughly card-indexed and class ified. Care is being taken to pick ou those specifications which are mos urgently needed, and due considera tion is being given to the attitude o purchasers and consumers toward th existing and the proposed specifica tions.

The Determination of Chimney Sizes

Method of Proportioning Chimneys Described in Paper Presented at Spring Meeting of American Society Mechanical Engineers

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It is probable that no engineering subject is in such a chaotic state as that of chimneys. While much excellent work has been done and many formulas, tables and charts have been prepared, chimneys are nevertheless usually designed by rule of thumb, and there are plenty of cases where their performance is either much greater or much less than was expected.

It is believed that the method of proportioning chimneys outlined in what follows has the merit of giving definite sizes which are entirely free from conjecture, in a very simple and consistent manner.

Description of the Method.—It is convenient to consider the available draft at the chimney base as being the static draft less the draft lost by chimney friction and by acceleration

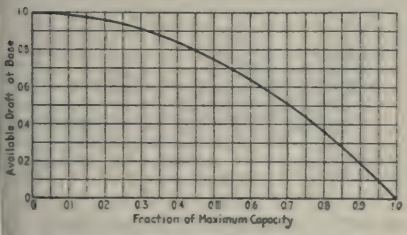


Fig. 1—Relation of Draft Fraction to Capacity Fraction (Available Draft Ratio).

of the gases, and this must equal or exceed the draft necessary to operate the boiler, etc.

The static draft is the vacuum prevailing under an imaginary condition when no gases are flowing. It is an absolutely definite quantity for any given circumstances and forms the starting point of this method.

The chimney friction varies as the square of the velocity of the gases. If the velocity is progressively increased, a point is reached where the chimney friction is equal to the static draft. This is the "maximum capacity," and it is just as absolute and definite a quantity for any given circumstances as is the static draft from which it is determined, and it forms the end point of the method.

The draft loss due to chimney friction is in direct proportion to the height of the chimney. So also is the static draft. If we double the height of the chimney, we double both the

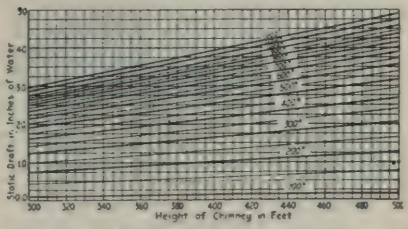


Fig. 2—Static Draft of Chimneys From 100 to 300 ft. High With Gas Temperatures From 100 to 1200° F. at Sea Level With Atmosphere at 60° F.
(Curves marked with mean temperature of gases in chimney in degree Fahr.)

static draft and the draft loss, and the maximum capacity is unaltered.

Since the chimney friction increases as the square of the velocity of the gases, the resulting curve is a parabola in all cases. This curve is presented in Fig. 1, and relates the load expressed as a fraction of the maximum capacity to the available draft

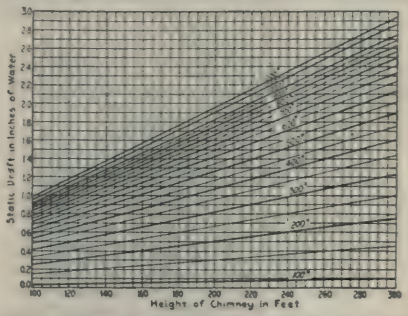


Fig. 3—Static Draft of Chimneys From 300 to 500 Ft. High With Gas Temperatures From 100 to 1200° F. at Sea Level With Atmosphere at 60° F.
(Curves marked with mean temperature of gases in chimney in degree Fahr.)

expressed as a fraction of the static draft. This is a fundamental curve which applies to all chimneys at all temperatures of gases and of the atmosphere and at all altitudes.

Static Draft.—Figs. 2 and 3 give the static draft for chimneys 100 to 500 ft. high at sea level dealing with gases up to 1200° F. in temperature when the atmosphere is at 60°. Another chart in the complete paper deals similarly with chimneys from 0 to 100 ft. in height. Fig. 4 gives factors with which to multiply the

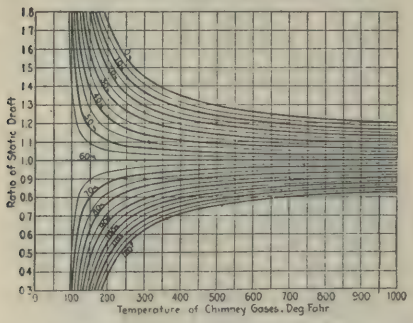


Fig. 4—Relation of Static Draft of Chimneys With Temperatures of Atmosphere From 0 to 120° F. to That at 60° F.
(Curves marked with temperatures of atmosphere in degree Fahr.)

static draft found from Figs. 2 and 3 to obtain the static draft for atmospheric temperatures other than 60°.

Temperature of Gases in Chimney.—The author's article on "Loss of Heat in Brick Chimneys," published in Power Plant Engineering, Aug. 1, 1921, includes some curves of temperature drop. These lead to the factors of Fig. 5, by which the mean temperature in the chimney may be found.

Altitude and Static Draft.—The static draft at any barometric pres-

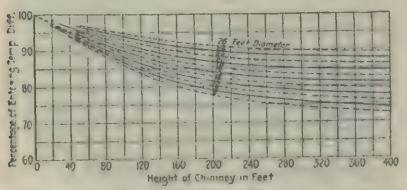


Fig. 5—Factors for Finding the Mean Temperature of the Gases in Chimneys.
Procedure (Masonry Chimneys):
A = observed temperature of atmosphere
E = observed temperature of gases entering chimney
P = percentage appropriate to diameter and height as read from chart
G = temperature of gases entering chimney above that of atmosphere = E — A
C = average temperature of gases in chimney above that of atmosphere — G × P
C + A average temperature of gases in chimney

sure B in inches of mercury is tha at sea level multiplied by $B/30$. I the same load is to be carried at alti tude as would be carried at sea leve then the same weight of gases mus be dealt with. Since the density o the gases is less, their velocity mus be higher, and the height of chimne necessary at altitude to provide suff cient draft to do the same work a at sea level, will be the sea-leve height divided by $(B/30)^2$, or mult plied by its reciprocal which is give in Fig. 6.

Maximum Capacity.—Menzin, in hi paper on Proportioning Chimneys o a Gas Basis, Trans. A.S.M.E., 191 went so carefully over all the avai able data on chimney friction that th formula he presented has been use Fig. 7 gives the maximum capacitie of chimneys from 5 to 25 ft. in d ameter for various mean tempera tures of gases with the atmosphe

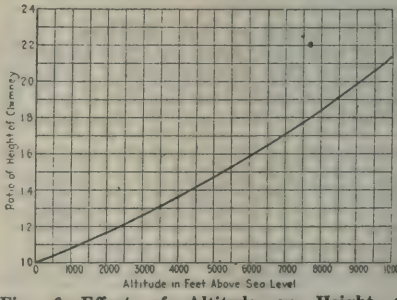


Fig. 6—Effect of Altitude on Height Chimneys.

at 60° at sea level. Other charts i the complete paper cover the rang for diameters of from 0 to 10 ft. Th maximum capacities as read fro Fig. 7 are to be multiplied by th appropriate factor read from Fig. when the atmospheric temperature other than 60° F.

It is convenient to assume that th velocity of the gases remains co stant. Then the maximum capacit at altitude is that at sea level mult plied by $B/30$.

Acceleration of Gases.—The pre sure difference required to accelerat the gases is conveniently stated a draft loss, and curves showing th draft loss at maximum capacity fo each diameter have been drawn i Fig. 9, for different temperature The fraction of the draft loss for an desired fraction of the maximum ca

pacity is the same for all maximum capacities. Fig. 10 gives this fraction.

The draft loss at sea level multiplied by $B/30$ give the draft loss for altitudes.

Available Draft.—Enter Fig. 1, with the ratio of available draft to static draft, and read the fraction of maximum capacity. Divide the required weight of gases by this fraction and use the resulting maximum capacity to find the requisite diameter. Or with given diameter, read the maximum capacity and state the required capacity as a fraction of it. Divide the required draft by the fraction read from Fig. 1 and get the equivalent static draft. Add the draft required to accelerate the gases and read the height of chimney from Fig. 2 or Fig. 3. Several combinations of height and diameter can be found for any circumstances very quickly.

Draft Required.—The draft required at the base of the chimney is made up as follows:

1. Vacuum Over Fuel Bed.—Fig. 11 shows the vacuum required in the furnace chamber for burning various fuels. The values are fair averages which accord with the author's experience with reasonably clean fires when hand firing and with average conditons of stoker operation. The broken-line curves were kindly supplied by Mr. Thomas A. Marsh, Mem. A.S.M.E. With forced draft, a vacuum over the fire of about 0.1 in. should be maintained.

2. Draft Loss Through Boiler Setting.—A curve should usually be obtained from the boiler manufacturer based on some proportion of excess air with the fuel to be used.

The draft loss through a horizontal, diagonally baffled, 14-high water-tube boiler burning bituminous coal with 13 per cent of CO_2 in the flue gases is given in Fig. 12.

The effect of an alteration in the amount of excess air as indicated by the proportion of CO_2 in the flue gases is shown approximately by the curves drawn in Fig. 13. Precise factors are not possible, but these are sufficiently accurate for the present purpose. The draft loss for any percentage of CO_2 is to be multiplied by the appropriate factor to find the draft loss at some other percentage of CO_2.

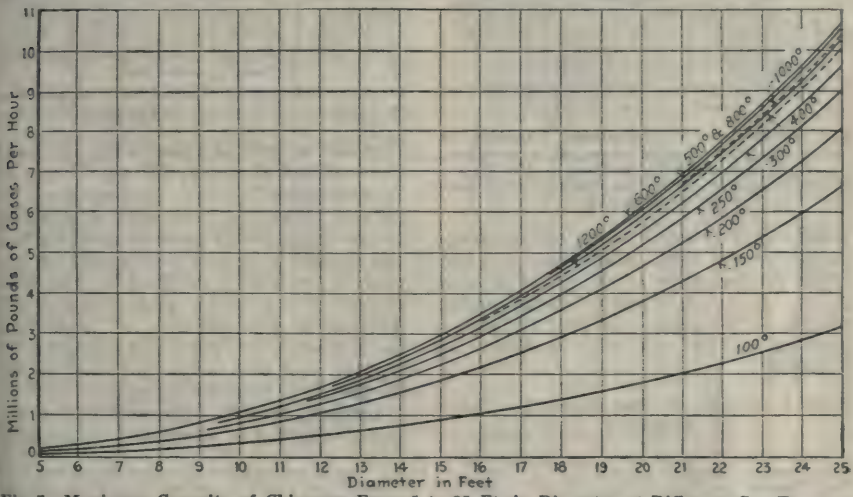


Fig 7—Maximum Capacity of Chimneys From 5 to 25 Ft. in Diameter at Different Gas Temperatures from 100 to 1200° F. at Sea Level With Atmosphere at 60° F.

3. Draft Loss Through Damper.—Some may prefer to allow a little draft loss through the damper, the damper being not fully open, as a factor of safety. But this is quite unnecessary with the method of treatment being described. Of course, in some ill-designed plants there may be a real draft loss through the damper frame owing to its being too small, or through the damper's causing serious distortion of the stream lines when fully open.

4. Draft Loss Through Flues.—The drart loss through flues is commonly taken as 0.1 in. of water for each 100 ft. of length and 0.05 in. for each right-angle turn. This value results

in the curves of gas weights and velocities of Figs. 14 and 15 for a temperature of 540° and for rectangular flues whose sides have a ratio of 2:1. Other figures in the complete paper give factors for finding the

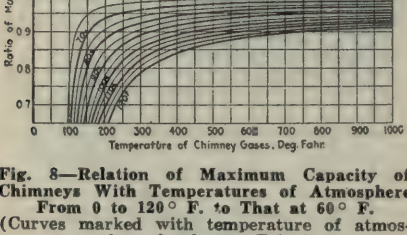


Fig. 8—Relation of Maximum Capacity of Chimneys With Temperatures of Atmosphere From 0 to 120° F. to That at 60° F.
(Curves marked with temperature of atmosphere in degree Fahr.)

weight and velocity at other temperatures for the same draft loss, and the effect of the shape of the cross-section of the flue. A further development results in the curves of Fig. 16, which are based on the gas weights of Table I.

Table I—Weight of Flue Gases for Boiler Horsepower

Conditions	Lb. of Gases Per Hp.
Coal, natural draft	90
Coal, forced draft	60
Natural gas	60
Oil	45
Blast-furnace gas	100

The loss due to elbows is generally assumed as 0.05 in. for right-angle turns whose inside radius is not less than the width of the flue.

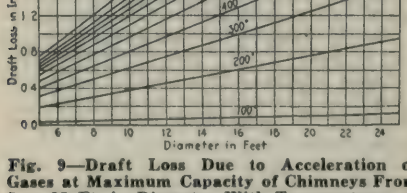


Fig. 9—Draft Loss Due to Acceleration of Gases at Maximum Capacity of Chimneys From 5 to 25 Ft. in Diameter With Temperatures of Gases From 100 to 1200° F. at Sea Level.
(Curves marked with mean temperature of gases in chimney in degree Fahr.)

The effect of different amounts o excess air on the draft loss in flues i the same as for the boiler setting a shown by Fig. 13.

Weight of Gases.—The weight o gases to be dealt with from any give fuel depends upon the proportion o excess air. It is convenient to calcu

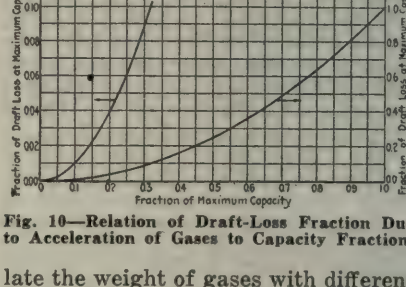


Fig. 10—Relation of Draft-Loss Fraction Du to Acceleration of Gases to Capacity Fraction

late the weight of gases with differen proportions of excess air per pound o "combustible." Any percentage o refuse, including unburned coal goin to the ashpit, can then be used to fin the weight of gases per pound of dr coal or of coal "as fired." The effi ciency of the boiler and furnace wil determine the weight of coal pe horsepower or per unit weight o steam, and the weight of coal to b burned can then be found.

Induced Draft.—Chimneys for in duced draft are computed in exactl

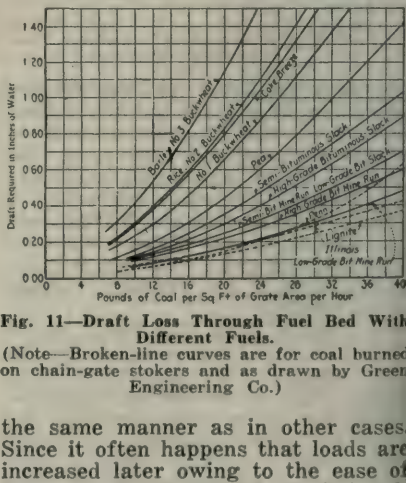


Fig. 11—Draft Loss Through Fuel Bed With Different Fuels.
(Note—Broken-line curves are for coal burned on chain-gate stokers and as drawn by Green Engineering Co.)

the same manner as in other cases Since it often happens that loads are increased later owing to the ease o doing so with induced draft, it is advisable to allow at least 0.2 in. o available draft at the fan discharge

Approximate Sizes.—Fig. 17 is drawn for a working capacity of 30

per cent of the maximum capacity. The natural-draft curve is computed at 90 lb. of gases per boiler horsepower, the forced-draft curve at 60 lb., and the oil-burning curve at 45 lb.

Fig. 10 shows that at 0.3 of maximum capacity the draft loss due to acceleration of gases is 0.09 of that

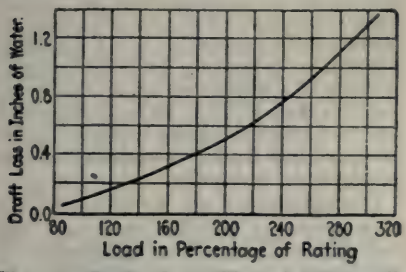


Fig. 12—Draft Loss Through Diagonally Baffled Boiler 14 Tubes High With Superheater, Burning Bituminous Coal With 13 Per Cent of CO_2 in Flue Gases, at Sea Level.

at maximum capacity, or, say, 0.10 for use in this approximate way. Fig. 1 shows that the available draft at 0.3 of maximum capacity is 0.91 of the static draft. Therefore the draft required at the chimney base divided by 0.9, for this approximate work, and added to the draft loss due to acceleration of gases gives the required static draft. The necessary height of chimney can then be directly read from Fig. 2 or Fig. 3 after making due allowance for temperature drop with the aid of Fig. 5.

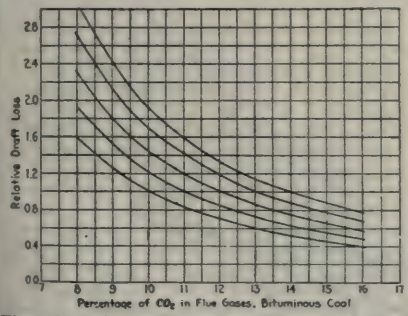


Fig. 13—Relative Draft Loss Through Boilers Burning Bituminous Coal With Varying Proportions of Excess Air as Indicated by the Percentage of CO_2 in the Flue Gases.

The accuracy of the results depends only upon that of the constants. For all ordinary cases only a few of the charts are used, and it is an exceedingly simple matter to solve any problem.

Chimney Study.—A central power station is to have groups of four 1400-hp. boilers to each chimney. The boilers are to be 14 tubes high and are to carry peak loads of 300 per cent of rating when the exist gases will be at 640°. Forced-draft stokers are to burn bituminous coal of known

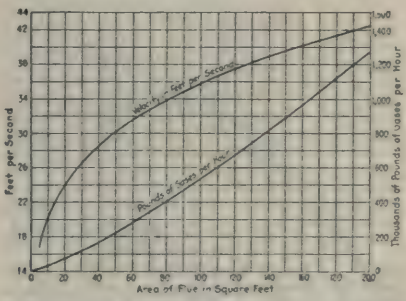


Fig. 14—Working Capacity of Rectangular Flues From 0 to 200 Sq. Ft. in Cross-Sectional Area With Sides in Ratio of 2:1 With Gases at 540° F. at Sea Level, Giving a Draft Loss of 0.1 In. of Water Per 100 Ft. of Length.

analysis with 30 per cent of excess air.

An approximate idea of the chimney is first arrived at. The total horsepower to be handled at 16,800, for which a diameter of 16 ft. is read from Fig. 17.

The draft required at the base of the chimney is found to be 1.55 in., made up of 1.3 in. draft loss through

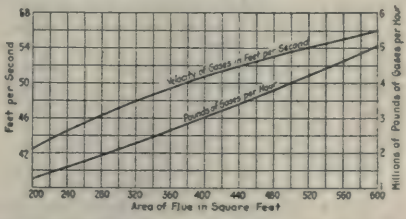


Fig. 15—Working Capacity of Rectangular Flues From 200 to 600 Sq. Ft. in Cross-Sectional Area, With Sides in Ratio of 2:1 With Gases at 540° F. at Sea Level, Giving a Draft Loss of 0.1 In. of Water Per 100 Ft. of Length.

boiler (from Fig. 12), 0.15 in. draft loss through the flues, and 0.1 in. vacuum over the fire. Dividing this by 0.9 gives 1.72 in. as equivalent static draft, to which is added an assumed 0.1 in. for acceleration of gases, making a total static draft of 1.82 in. Assuming a mean temperature of chimney gases of 550°, a height of 270 ft. is found from Fig. 2.

The combustion data for the coal are worked out and the total weight of gases per pound of combustible found. Using the predicted boiler and furnace efficiency, the weight of combustible per hour is found and then

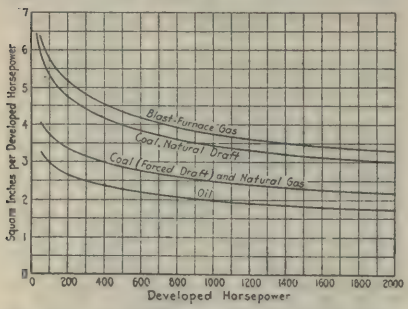


Fig. 16—Area of Rectangular Flues in Square Inch Per Developed Horsepower With Sides in Ratio of 2:1, Which Will Give a Draft Loss of 0.1 In. of Water Per 100 Ft. of Length at Sea Level.

the weight of gases per hour. Tabulation of data is then commenced as in Table II, using a number of diameters above and below the first approximation. The first approximation of heights appropriate to the listed diameters is given in column 7 and is made on the assumed mean temperature and gas acceleration loss. A close determination is now made of mean temperature in accordance with each combination of approximate height and diameter and of the actual loss due to acceleration of gases. This leads to a new series of heights as entered in column 15. A curve of heights as in column 15 is now drawn against the diameters of column 1 as the full line of Fig. 18 and simplifies the final choice. Such a curve shows the practical limits at each end of the series very decidedly.

It was pointed out by Deinlein that of a series of possible chimneys, the one whose product of diameter by height was the smallest would be the least expensive. These products are entered in column 19 of Table II and their curve drawn in Fig. 18 as the broken line. The lowest point in this curve occurs at 14 ft. 6 in. diameter, where the height is 289 ft. The author is indebted to Mr. George H. Gibson, Mem. A.S.M.E., for this information.

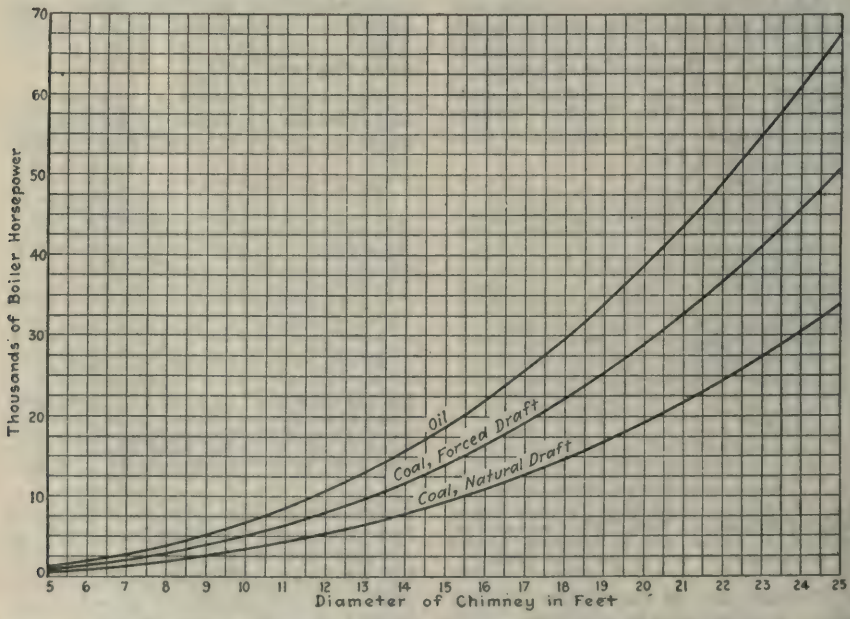


Fig. 17—Working Capacity of Chimneys From 5 to 25 Ft. in Diameter, Based on Boiler Horsepower With Atmosphere at 60° F. at Sea Level.
(Maximum capacity—95 per cent of maximum capacity with mean temperature of gases at 900° F. Working capacity—30 per cent of maximum capacity (or 28.5 per cent of maximum capacity at 600° F.). Weight of gases 90 lb. per hour for natural-draft coal, 60 lb. per hour for forced-draft coal, and 45 lb. per hour for oil, per boiler horsepower.)

A problem frequently met with is that of modernizing and increasing the steaming capacity of a plant while using the existing chimney.

A curve of exit gas temperatures is first drawn and then a curve of the corresponding mean temperatures of

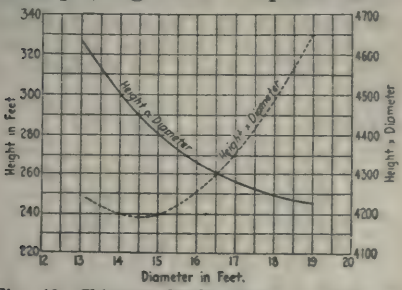


Fig. 18—Chimney Study Giving a Series of Combinations of Height and Diameter.

the chimney gases as in Fig. 19. These are used to determine the characteristics of the chimney as in Fig. 20; and as this is based on weight of gases, it must be related to Fig. 19, which necessitates a curve of gas weight per horsepower depending on the curve of efficiency. The draft loss through the boilers is determined and plotted. The areas and arrangement of flues are carefully examined because desirable reduction of their draft loss can usually be made by redesigning them. The predicted flue draft loss added to the boiler draft

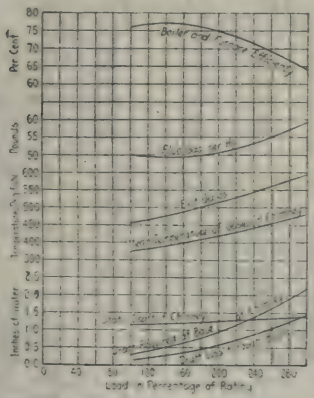


Fig. 19—Chimney Study. Performance Data of an Existing Chimney.

loss and to the vacuum necessary over the fire, will enable the curve of draft required at base of chimney to be drawn as in Fig. 19. With the mean temperature of chimney gases, the static draft for different loadings is read from Fig. 2 and plotted.

The fraction of static draft for different fractions of maximum capacity is found from Fig. 1, and the equivalent draft for each percentage of boiler rating noted. The loss due to acceleration of gases is then found and deducted therefrom, leaving the available draft at the base of the stack at each percentage of rating at

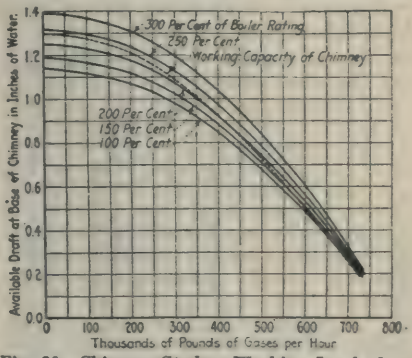


Fig. 20—Chimney Study. Working Load of an Existing Chimney at Different Boiler Ratings.

which the boilers might be worked. Curves are then drawn of these available drafts as in Fig. 20. The draft required at different ratings is read from Fig. 19 and enables the broken-line curve of maximum chimney load at different boiler-rating loads to be drawn in Fig. 20.

The actual boiler horsepower which

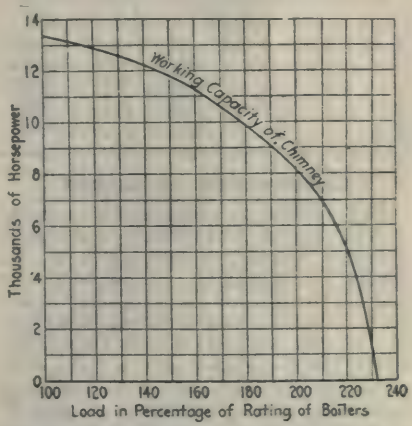


Fig. 21—Chimney Study. Reduction of Working Capacity of an Existing Chimney at Increased Boiler Ratings.

the chimney will carry at different boiler ratings is obtained by dividing the total gas weights of Fig. 20 by the gas weight per horsepower of the curve of Fig. 19. To show this more

clearly, the curve of Fig. 21 may be drawn. This curve emphasizes how the chimney capacity is governed by the draft loss of the boilers and flues. If the flues were enlarged, the chimney capacity would be greatly increased. This curve also shows that the capacity of the chimney is increased enormously if the boilers are run at low ratings owing to the much lower draft loss at low loads.

The requirements may be met by reducing the excess air, by improved methods of firing, by installing induced draft, or by adding more boilers and running at lower boiler ratings. The first and last methods increase boiler efficiency and save coal, while the second method increases the coal consumption by running at higher boiler ratings where the efficiency is lower.

Table II—Chimney Study

(1) Diameter in feet	(2) Maximum capacity as in Fig. 7	(3) Working capacity = fraction of maximum capacity	(4) Draft required, fraction of static draft	(5) Draft required, 1.55 in. ÷ col. (4)	(6) Static draft required = col. (5) + 0.1 for gas acceleration	(7) Height with mean temperature at 550 deg. fahr.	(8) Factor for mean temperature	(9) Mean temperature difference	(10) Mean temperature of chimney gases
13	2,000,000	0.429	0.815	1.902	2.002	297	0.795	461	521
14	2,380,000	0.360	0.870	1.782	1.882	280	0.805	467	527
15	2,820,000	0.304	0.908	1.707	1.807	268	0.815	473	533
16	3,320,000	0.258	0.932	1.663	1.763	261	0.824	478	538
17	3,860,000	0.222	0.950	1.632	1.732	257	0.833	483	543
18	4,450,000	0.193	0.962	1.611	1.711	253	0.841	488	548
19	5,090,000	0.169	0.971	1.596	1.696	251	0.849	492	552

Diameter in feet	(11) Draft loss by gas acceleration at maximum capacity	(12) Fraction of gas acceleration at working capacity	(13) Gas acceleration at working capacity	(14) Total static draft required	(15) Height required at mean temperatures of col. (10)	(16) Factor for mean temperature	(17) Mean temperature difference	(18) Mean temperature of chimney gases	(19) Product of height by diameter
13	1.30	0.183	0.238	2.140	327	0.792	459	519	4251
14	1.40	0.130	0.182	1.964	300	0.803	466	526	4200
15	1.51	0.092	0.139	1.846	280	0.814	472	532	4200
17	1.73	0.049	0.085	1.717	256	0.833	483	543	4352
18	1.84	0.037	0.068	1.679	249	0.842	488	548	4482
19	1.95	0.028	0.055	1.651	245	0.850	493	553	4655

Construction in August

The decline in construction volume which began in June continued through August, according to F. W. Dodge Corporation. However, the August drop from July was only 5 per cent. Total August building contracts in the 36 eastern states (including about seven-eighths of the total construction volume of the country) amounted to $298,629,000. In the 27 states for which records were kept last year, the drop from August, 1922, was 15 per cent. In these 27 states the construction started during the first eight months of this year has been just equal to the amount for the corresponding period last year, although on June 1 this year had a lead of 15 per cent over last year. This year's construction volume to date in the 36 eastern states has amounted to $2,723,911,000.

Last month's record for the 36 states included the following important items: $126,871,000, or 42 per cent, for residential buildings; $62,664,000, or 21 per cent, for public works and utilities; $37,457,000, or 12 per cent, for business buildings; $25,861,000, or 9 per cent, for educational buildings; and $19,359,000, or 6 per cent, for industrial buildings.

Contemplated new work reported in the 36 states last month amounted to $508,484,000, a decline of 20 per cent from the amount reported in July.

New Features in Apartment House Building

The Jackson Heights Development, New York, Described in Address Presented June 29 Before the Convention of the National Association of Real Estate Boards

By E. A. MAC DOUGALL
President, The Queensboro Corporation, New York

There are two essential new features of these apartment houses. From the economic standpoint the apartment will be sold on a co-operative basis to its tenant-owners. From the structural standpoint it will have an interior garden with all that it implies and connotes. The builder who fails to recognize at this time the need of providing houses of a type that make for economy of use as well as of cost fails to meet the demand of the public. The architect of apartment houses, too, must provide in his planning, for all the advantages, such as section, as the highly restricted beautiful residential district of Cleveland affords.

These new features have already been put into effect in the garden apartment development at Jackson Heights. If I speak later of this particular development I do so only in order to deduce from a successful experiment the general principle which must apply in the solution of the entire problem. Let me tell you how these two features developed.

The Park Avenue District.—First, however, let us describe for the sake of later comparison, the Park Avenue district of Manhattan Island, which is in a way typical of the better apartment house districts of other cities. It is the section most sought after by wealthy people in New York City and where the most expensive type of apartments are still being built. Land values here are very high. On the streets leading off Park Avenue, which do well for purposes of comparison, the apartments are of six, seven and eight rooms.

Even this relatively high cost of land per family is based on the use of 70 per cent to 90 per cent of the land area. The buildings often hold several hundred families. It is necessary, in that neighborhood, to cram just as many human beings as can be persuaded to live there, on a given area of land.

In these Park Avenue buildings of the best type some of the apartments, principally those which front on the street, have good light and air, but many of the rest, those on the sides and rear, have a narrow outlook on small courts. Custom makes people put up with these conditions but comparison with the individual house is inevitable and unfavorable. Then, too, many of these Park Avenue properties depend for their light and air on their neighbors. There are still many low buildings in this district. As soon as they are "scrapped" as they are bound to be, and the neighboring properties improved, many of these luxurious apartments, bringing high rentals, will lose their sunlight and outlook, and their rental value will be heavily depreciated.

At Jackson Heights we have not the same hampering restrictions as has the Park Avenue district, where the land is already well built up, good plottages are difficult to obtain, and where the land is excessively costly, compelling building high in the air.

We control a tract of land about one-half as large as Central Park, which was farm land within the memory of people living. We have developed it from raw land and built as large groups as was possible whether from the point of view of design or of economy of construction.

We have learned as a result that a city block is the best unit of apartment building. By studying the cost per family of the land used and keeping in mind that we must compete with the individual home, we have discovered that we can build as low as 38 per cent of the lot area covered in seven and eight-room apartments, only six stories high and create a wonderful garden and open space.

We can build in small units with only two families to a floor assuring privacy. Each apartment has three or four exposures like a country house. The principal rooms and some of the bedrooms are corner rooms and the space between the buildings is 36 ft. 8 in., so that the buildings are separated, not so much by passage-

ways as by lawns. These side lawns open into a vast interior garden running the whole length of the block, 80 ft. or more in width, providing an outlook and a garden character which is unthinkable in Park Ave. In fact, it can seldom be found in any save the largest estates.

Progress and Improvement.—Briefly, here is the story of how we have improved the type of apartment, year by year.

In 1920 we built a block of twelve four-story walk-ups, apartments designed by Andrew J. Thomas, in which the passageways between the buildings were 15 ft. The kitchens and fire escapes and some of the baths were on these passages. This space added greatly to the value of the apartments since in Summer they did much to create a circulation of air and to admit sunlight to the group. This group occupied about 40 per cent of the area of the block.

This group attracted to Jackson Heights many people who wanted more luxurious five and six-room apartments with larger rooms than could be had in the four and five-room apartments and we, accordingly, had Mr. Thomas design this group of apartments called the Chateau Apartments. We carried up the buildings to five stories, two apartments to a floor, using push button elevators. We reduced the area occupied by increasing the side spaces between the buildings to 19 ft. 6 in. in the shortest dimension. The buildings were fireproof on the first floor with fireproof exterior walls, roof, and elevator and stair wells.

The 1924 Design.—This proved successful and as a result we have now under construction a third improvement, our 1924 model. In this group the apartments are of seven and eight rooms on an average. We retained the general plan of having two apartments to a floor and improved the older group in every respect that we could think of, whether it was in planning the arrangement or little details and refinements of construction and specifications. The big improvement was in adding another story, in making the buildings fireproof and placing the building 36 ft. 8 in. apart, and in making the area occupied by the buildings 38 per cent. We feel that we now have a model which has all of the advantages of the Park Ave. apartment without its weakness, and which really competes with the individual home.

One New Feature—Co-operative Ownership.—Co-operative Ownership which we have adopted at Jackson Heights is one of the things that makes possible this type of apartment. The family which owns a co-operative apartment is there to stay and they look upon it as a permanent home. They are consequently just as particular to have it perfect and complete in every respect as if they were going to the best architect and having him design for them the best individual home that he could produce.

The rental apartment, on the other hand, is not built for permanence, but often as a speculation. The tenants are apt to look upon it as a temporary refuge and they are more ready to live in four or five-room apartments with possibly one bath.

In a co-operative apartment, seven or eight rooms are a better size with two or three baths, servant's room and bath and the most complete kitchen and dining arrangements, closet space and other details.

Since the war, the increased cost of renting has become so great that many apartment dwellers have been unable to keep up their apartment homes. Caught between the expenses of private home ownership and the expenses of rental of an apartment, apartment ownership by tenants has been a national solution and should continue to be so.

Tenant-ownership in itself is not new. It goes back both in this country and abroad to the time of the first apartment building. In some instances in the early days perpetual leases were given to tenants. These leases become very difficult to handle as death and changes introduced complications in the original ownership of the buildings. But here too American ingenuity gradually overcame difficulties and developed a mode of procedure.

Nowhere, either in Europe or in America has co-operative ownership been applied in a larger way than by the Queensboro Corporation at Jackson Heights. Here, profiting by mistakes made in the past in the form of organization and benefiting to some problems in other cities, the Jackson extent by the solution of similar problems in other cities, the Jackson Heights Plan of Tenant-Ownership was evolved.

This plan, although worked out indepently by the Queensboro Corporation has many points of similarity with what is known in England as Co-Partnership Tenant Plan. In England industrial villages were built by funds suscribed by workers and others; these workers obtained stock for their contribution and were privileged to rent buildings in the development. If a change of employment forced them to move, they could leave the premises and still retain a return upon their investment in the stock which they owned in the co-partnership enterprises.

In this way the loss and sacrifice frequently involved in the ownership of an individual home were avoided, and at the same time, the freedom of action of the worker was not interfered with.

Any such plan as the Jackson Heights Plan involves the organization of a company to take title to a piece of property upon which there is erected an apartment building. The title to the house and lot resides in the company. Its stock is sold pro rata to the persons who occupy the building. The occupants lease their apartments from the company in which they are stockholders and thus become actually their own landlords and pay rent to themselves.

No limitation is placed on the sale of the stock, but the lease which is a yearly lease renewable at the option of the tenant indefinitely is a personal lease with the tenant and cannot be assigned without consent. This is considered to be one of the strong features of the Jackson Heights Plan in that it prevents deterioration in the tenancy of the building by reason of transfers to undesirable parties. The value of the stock which rests largely in the lease is therefore effectively controlled.

Whenever the fee has been passed in unrestricted real estate developments, it has usually been found impossible to restrict the transfers of this fee and sooner or later there is a tendency toward deterioration in the class of people living in the section. It is believed that for tenant-owners the Jackson Heights Plan protects so far as is humanly possible from this deteriorating tendency.

The management of the buildings is in the hands of an experienced manager. At Jackson Heights the Queensboro Corporation manages all of the co-operatively owned buildings and is therefore enabled to effect economies by large scale purchases.

The tenant-owners merely pay in their monthly contributions toward upkeep, etc., and as directors of the Corporation meet to receive the reports of their agents at proper intervals.

But there is another element to be borne in mind in this discussion, and that is the structural element I have already mentioned. The new conditions—the uneconomic ownership of private single residences and the economic ownership of apartments by tenants have developed these new structural aspects of the apartment home. These new conditions have brought about a new architectural point of view and architectural accomplishment.

The Other Feature—Interior Gardens and New Structural Features.—The architect of city homes has an important duty to perform in improving along scientific lines the design and construction of multiple family houses so as to provide the healthful, wholesome atmosphere of an individual house with its sunlight, privacy and pride of ownership combined with the convenience, efficiency and economy possible only in a multiple family house.

Summed up, experience at Jackson Heights has shown the following to be the essentials of good planning of multiple family houses:

1st. Comprehensive block development rather than unsymmetrical and irregular height and type of building which has heretofore prevailed.

2nd. Maximum of sunlight and ventilation insured by the erection of buildings two rooms deep on the four sides of the block with an interior garden; the interior garden taking in the entire length of the block and being a substitute for the old type of development with its individual back yards, fences, clothes lines and other unsightly features. This immediately brings down the area of the building from 70 per cent—the maximum permitted by the N. Y. Tenement House Law to as low as 30 per cent to 35 per cent of the lot built up. Such gardens are at Jackson Heights, 500 ft. long by 70 to 100 ft. in width, and are created for the enjoyment of all the tenants in the block. Noted architects have planned these gardens. A man ccupying a five, six or seven-

ent enjoys a garden room apartn was only within the which formerly re. To insure the means of a millionaire gardens, the permanency of these ilding com- land is dedicated by the b benefit pany by proper deed for the use of the adjacent owners and its restricted by covenants running w the land.

3rd. Buildings are set back from the lot line in order to provide distance between buildings and an opportunity for lawns and planting in front of the house.

4th. The building of detached or free standing apartment buildings which give an opportunity for many corner rooms and consequent cross ventilation.

5th. The silhouette produced through a picturesque arrangement of roofs and dormers, towers and other features adds a great deal to the attractiveness of the new type of apartment.

At Jackson Heights in the Chateau group, for instance, the roof is of medieval French Chateau type of vari-colored slate.

The Cambridge Court has cornice and balustrade of the Georgian type of building, with slate roof and dormer of the Colonial architecture of the 18th Century. The inspiration was to some extent derived from the freshmen dormitories of Harvard University along the Charles River, which are a noted American application of the Georgian style. In another group the Italian effect is shown. In yet another, the English.

The movement toward co-operatively owned apartments of attractive and convenient design is, of course, not confined to New York. While it has taken hold to a large extent in New York, it has been tried in other cities in the United States, largely because of the success which the plan has met with at Jackson Heights, where over 1,100 tenant-owners are now living in over 100 apartment buildings.

The Tenant-Ownership Movement. The plans of tenant-ownership applied elsewhere in New York and in other cities throughout the country vary in detail from that described as The Jackson Heights Plan of Tenant-Ownership, but in essence are the same. The transfer of the lease is controlled by the tenant-owner corporation so as to protect the other people living in the building.

In Europe, tenant-ownership is of older standing than in this country. The growth of the plan has been fast in Paris for the same reasons as have caused its growth in New York—high rents, scarcity of accommodations and the feeling on the part of the former renter that he is spending too much for rent with little to show for it.

Several large apartment buildings ving an entire block are being in Paris in the vicinity of the occu Mars by the Societé erected Franco-Americainé, in Champ de Anonyme treatment of the which the artist bined with the French is being co the American practical comforts of ownership apartment. This tenant- Ger- movement has also spread many and to the Scandanavian c tries, where many handsome apartments are co-operatively owned. This movement may be said to combine the comfort, ease and economy of apartment living with the freedom and sense of independence which goes with ownership. In this respect it is an internationally important movement in that the best citizen is the man who owns his own home. At the same time it is in keeping with the trend of the times which compels people to give consideration to economy in their living.

Shows Way to Make Better Lime

Experiments conducted at the U. S. Bureau of Standards have shown a way to improve the manufacture of hydrated lime so that the grade known as "finishing" hydrate is regularly produced instead of the grade known as "masons" hydrate which, because of its lessor plasticity, commands a lower price. These tests have shown that plasticity depends not alone upon the colloidal content of the hydrate, but upon the effect on this colloid of the manufacturing process. The colloid, like glue, must not be allowed to dry out during the manufacturing process, and it must also be prevented from flocculating itself when the mixing water is added preparatory to use. It has been found that the drying out can be prevented by letting the freshly made hydrate cool in an atmosphere of steam, while flocculating can be prevented by adding small amounts of a readily soluble calcium salt. A hydrator designed to apply these principles has just been completed for further experiment.

Longview, Washington

A Modern, Planned City Now Being Built for the Long-Bell Lumber Company and Other Industries

A few years ago the Long-Bell Lumber Co., which for almost 50 years has been engaged in the lumber business in the south and middle west, investigated and purchased a large body of timber in Cowlitz and Lewis counties, Washington, about 15 miles north of the Columbia River. Following the timber purchase, an investigation was made of possible locations for lumber manufacturing plants which would have tide-water as well as railroad facilities and a site of 14,000 acres was selected on the peninsula formed by the juncture of the Cowlitz and Columbia rivers, 50 miles inland from the Pacific Ocean.

A large body of land was necessarily acquired for operations, the construction of a great many homes and buildings was necessary to provide facilities for people to be employed by the lumber company, and as plans were worked out it was found that the location selected would lend itself to greater development and provide facilities larger than were required for the company's own use. It was accordingly decided to provide a town that would be a desirable place for a considerable population and a varied business. The name "Longview" was chosen for the new town, and it is expected it will have a population of 25,000, and within the next ten years 50,000 or more.

The Long-Bell Lumber Co. plans to confine its activities exclusively to the production and distribution of lumber products, hence an associate company, The Longview Co., was incorporated to forward the development of the new city independently of the manufacturing operations of the Long-Bell Lumber Co.

The Lumber Company's Plant and Business.—On 2,000 acres of the land, the Long-Bell Lumber Co. is erecting its plants, which when completed will have an annual capacity of between 400 million and 500 million feet of finished lumber products. The latter figure is practically equivalent to the total production of 11 saw mills now operated by the same company. It is estimated that an operation as large as the one planned, when completed, will in itself employ the services of between 3,000 and 4,000 men. Counting those employes and their families, together with the many persons required to serve such a community, a conservative estimate of the population that the new city will have within a very short time is 20,000 people.

The primary units of the lumber manufacturing plants will be two fir saw mills served by a 24-acre log pond, which is connected by a canal with a larger log pond of 126 acres. The latter pond is connected by a canal with an arm of the Columbia River, containing about 75 acres, which will be used also as a long pond. Other features will be a cedar and hemlock mill, sash and door factory and veneer plant.

Group of Small, Modern Homes in a Residential District Near the Industrial Section.

The lumber manufacturing plants will be electrically driven and a 36,000 kilowatt steam plant is planned to furnish this and other power.

Separate docks for vessels and freight cars will be built. Lumber and timbers cut for export will be stored apart from products designed for domestic markets. Hand labor and trucking will be practically eliminated by the use of overhead cranes and monorail trolleys, which will handle the products in "packages." Export and coastwise lumber and timber docks will accommodate eight large ocean-going vessels at a time.

The double track main line railroad between Portland and Seattle passes Longview on the opposite or east bank of the Cowlitz River, and is

Map Showing Proposed General Plan of Development.

used jointly by the Union Pacific, Northern Pacific and Great Northern railroads. The Longview, Portland & Northern Ry., a double track common carrier, is being built along the west bank of the Cowlitz and will connect with the trunk lines across the river over a bridge near the mouth of the Cowlitz, thus affording the new city direct access to the three transcontinental lines. The water frontage is 7¼ miles on the Columbia River and 5 miles on the Cowiltz River, the Columbia side being amply adequate in both width and depth for ocean-going vessels, while the Cowlitz is open to lighter draught navigation.

A City Planned by Experts.—When the Long-Bell Lumber Co. decided upon this city building project, the officials called to their assistance Mr. George E. Kessler, the firm of Hare & Hare and Mr. J. C. Nichols, all of Kansas City, and all well known in city planning activities. Mr. Kessler will be remembered as having laid out the Kansas City park and boulevard system, and for other notable city planning and landscape achievements. His last important work prior to his sudden death, in March of this year, was the advisory assistance he rendered in connection with the planning of Longview. The actual platting and planning of the town was done by the firm of Hare & Hare, landscape designers and town planners, Mr. S. Herbert Hare representing his firm on the site. Mr. J. C. Nichols, president of the J. C. Nichols Investment Co., owners and developers of the well known Country Club residential district in Kansas City, also acted as advisor in the working out of the project.

The plan provides thoroughfares and boulevards, 100 ft. or more in width, along all the principal natural lines of traffic. Some of these main streets radiate in various directions from the business center, yet they are so arranged in their relation to other streets that alternative routes are provided near the center and congestion of traffic is avoided. This arrangement of main thoroughfares tends to fix the permanent center and to avoid the shifting values so characteristic of American cities. All the business streets are of ample width, and the blocks are quite short in the business area, giving a high percentage of property in streets, while in the outer residential areas the blocks will be long. Thus the total area of streets in the townsite is distributed where it will be of the most value. In the hilly section, the streets are adjusted to the topography of the land, thus preserving the unusually fine scenery and building sites of these areas.

The Community House at Longview.

Alleys have been provided at the rear of most of the lots in both the business and residential areas. Pole lines will be arranged in these alleys, wherever possible, and in easements along rear lines where there are no alleys, thus clearing most of the streets of unsightly poles and allowing the undisturbed growth of street trees.

A 6-acre park has been provided at the center of the radiating thoroughfares, which is the focal point of vistas from various directions. Around this park will be grouped the various public and municipal buildings of a monumental character. While the park is at the convergence of the

radiating streets, it is not the center of traffic. A park area of 100 acres has been provided in a crescent-shaped parkway, from 500 to 800 ft. wide and 1½ miles long, surrounding the inner city on the westerly and southwesterly sides and bordered by two boulevards. There will be waterways through the park and ample areas of open lawn for recreation use. Other parkway treatments are being provided. All the outstanding natural beauties of the site will be preserved in park land. Areas which might become a menace to the city in private ownership because of being unsuitable for building are protected, and ample facilities for outdoor recreation of all kinds are provided in the park system.

In addition to the parks, very ample areas have been reserved for the school grounds, which will in themselves be local parks. For the grade schools, areas of five acres or more have been reserved, and there is one area of more than twenty acres for the junior and senior high schools and general recreation field. The areas for schools have been spaced in relation to anticipated future density of population, so that units of economical size can be developed.

The haphazard growth of most cities is not only due to an illogical and unrelated street plan, resulting from piece-meal development, but to lack of control of the uses of private property. In Longview, the city is planned so that various sections are especially fitted by location and character for development to certain classes of use, and by means of protective covenants in the deeds and plats, the buyers will be assured that property they purchase for a certain use will be surrounded by property of similar or a higher type of use. In furtherance of this end a complete zoning plan was prepared.

It has been said that city planning is not the planning of thoroughfares, boulevards, plazas, parks and playgrounds, nor the grouping of buildings into civic centers, nor the zoning of private property; it is not any one of those, but all of them together, and that is what is being done in Longview.

Industrial Development of the New City.—As has already been stated, it is planned that Longview shall develop a variety of independent industries; and the buildings and other improvements now under way are of the necessary permanent and substantial type to further that end. Progress to date includes the completion of upwards of 300 modern residences and a 200-room fireproof hotel. Two bank buildings, several office and store buildings, several apartments, and a school and a community house are under construction. The power plant and the first unit of the Long-Bell mill are also under way.

The First School Building.

The character of industries toward which the developers of the town are looking may be judged by consideration of the transportation facilities and the natural resources adjacent. Lumber, of course, is prime, but there are also the wheat of eastern Washington, Oregon, Idaho and Montana for flour milling or the manufacture of other cereal products; fruit, berries and vegetables for canning and preserving, as well as the production of fruit pulps and juices, vinegars and confections. Fish from the Columbia River and Washington and Oregon coasts suggest canning and utilization of by-products, such as oils and fertilizers; coal and other fuel and hydro-electric power invite the metal trades, the production of machinery and tools, compounding of chemicals, production of brick, tile and cement.

The proximity of numerous species of native woods in vast quantities, many highly adaptable for furniture

making, suggests the possibilities of that industry. In addition, by reason of the new city's favorable position in regard to ocean traffic, the furniture manufacturer can import, at low rates, rough hardwoods from South America and the Orient. Teakwood squares and rough mahogany are already frequent cargoes at other Pacific Northwest ports.

The facilities to bring native woods to the factory door, in almost any shape desired, invite a great variety of other wood-working industries. An indication of how such industries can be developed to a remarkable size is seen in Washington and Oregon today, where it is estimated that there is a daily production by door plants of 20,500 finished doors.

Still another industry that offers unusually attractive possibilities is that of paper making from wood pulp. Hemlock, spruce and silver fir are the species of wood considered as most suitable for mechanical and sulphite pulp, both of which are needed in the manufacture of newsprint paper. Those woods are found in vast quantities throughout the Pacific Northwest, especially west of the Cascade Mountains, a territory directly tributary to Longview.

The Identification of Douglas Fir Wood

Technical Note, U. S. Forest Products Laboratory

Douglas fir is one of the largest, most abundant and widely distributed species of trees native to North America, and next to the southern yellow pines, it is cut in the greatest quantities of any wood of commercial importance. It belongs to the coniferous family and is, therefore, a softwood. Other names for Douglas fir are red fir, yellow fir, Oregon pine, Puget Sound pine, red pine, red spruce and Douglas spruce. Its botanical name is pseudotsuga taxifolia.

Although Douglas fir is distinctly a western species, its use is gradually spreading eastward. It is used for structural timbers, railway ties, railway cars, rough and finish lumber, flooring, sash and doors, furniture, lath, cooperage, tanks, conduits, paving blocks, boxes, agricultural implements, and numerous other articles.

The principal softwoods used for the same purposes are the southern yellow pines, Norway pine, eastern hemlock, western hemlock, Sitka spruce, western yellow pine, western larch, and some of the balsam firs (principally white fir, lowland white fir, noble fir, and silver fir—all western species).

As there is a considerable range in the price and suitability of these various woods for various purposes, it is important to be able to distinguish the wood of Douglas fir from the others.

Douglas fir is a resinous wood, with a characteristic sweetis odor. Exudations of resin on end and side surfaces and pitch pockets are common. Occasionally pitch streaks occur. The sapwood, which is from 1 to 3 in. wide, is white. The freshly cut heartwood is light reddish yellow in color. On exposure to light and air it becomes distinctly reddish, sometimes cherry red, or reddish brown, except the outer portion of old trees which often remains light reddish yellow, which explains why the wood is sometimes known as yellow fir. The summerwood is pronounced, except in very narrow rings such as usually occur in the outer portion of old trees.

Under the microscope Douglas fir can easily be distinguished from other structural softwoods by the fine spiral thickenings on the inner side of the cell walls, similar to the thread in a nut.

The other softwoods mentioned can be distinguished from Douglas fir by the following characteristics.

Southern Yellow Pines, Norway Pine, and Western Yellow Pine.—Heartwood less reddish and more orange brown; characteristic pine pitch odor. On planed surfaces the resin ducts often are pronounced as brownish lines running parallel to the grain, whereas in Douglas fir the resin ducts are obscure.

Eastern Hemlock, Western Hemlock, and Balsam Firs.—No pronounced difference in color of heartwood and sapwood as in Douglas fir; exudations of resin, pitch pockets, and pitch streaks absent; odor not pronounced.

Sitka Spruce.—Color of heartwood pale pinkish brown; split or dressed surfaces have a "silky sheen"; tangentially split or dressed surfaces have a dimpled appearance as if hit with buckshot; odor not pronounced.

Western Larch. — Russet brown color; odor not pronounced.

Concrete Floor Hints for Contractors

Useful Notes and Information from Portland Cement Association on Heavy Duty Floors, Terrazzo Floors, Colored Floor Finish, Floor Treatment and Concrete Floor Coverings

Heavy Duty Floors for Industrial Buildings

The attractive appearance of terrazzo floors has long been recognized, but the use of this type of polished floor for industrial buildings is not so well appreciated.

The following is a description of the method of laying a heavy traffic floor in an eastern shoe manufacturing plant. This floor is subjected to the action of very heavily loaded steel-wheeled trucks, and the method of construction was adopted after tests of the wearing qualities of the floor under severe conditions.

The rough slab was first picked, swept and washed with clean water. One-inch round steel bars were then placed as grounds and leveled up. The floor was again wet down and a 1:1 cement sand grout brushed on. Before the grout had set a 1:2 mixture of cement and trap rock uniformly graded from ⅛ to ¾ in. was dumped on the floor and screeded off. The mixture was as dry as it was possible to dump out of the mixer. The grounds were then removed and the spaces filled with the 1:2 mixture.

Just about the time when the topping material was stiffening up an even coating of crushed trap rock was spread over the entire surface to a depth of ½ to ¾ in. and rolled into the surface with a 150-lb. concrete roller. This roller was operated longitudinally and laterally until the entire area had been evenly rolled. A 900-lb. roller was used next and last of all an 1,800-lb. roller was operated laterally, longitudinally and diagonally. This last rolling brought up some water and fine material to the surface.

As soon as possible after the final rolling the floor was given a hand steel troweling sufficient only to smooth out any of the stone that had been up-ended by the rolling processes. Twelve men were able to trowel about 15,000 sq. ft. of floor in two hours.

As a final operation the floor was ground with ordinary grinding machines using carborundum block and coarse powdered emery with a generous supply of water. The grinding operations were started from four to seven days after the topping had been placed.

After 19 months of severe trucking these floors are in excellent condition, and due to the smooth and even surface, the trucks do not produce the usual heavy rumbling.

Terrazzo Floors

A terrazzo floor finish is a surface of irregular marble or granite fragments embedded in cement mortar and ground to a smooth, even surface.

A terrazzo finish should preferably be 2 in. thick. Usually reinforcement is not required.

The terrazzo should be laid, if possible, before the concrete floor has hardened. If the concrete foundation slab is allowed to harden before the finish is placed, it should be left somewhat rough, and when ready to receive the finish it should be carefully cleaned, drenched with water and painted with a grout of neat cement of creamy consistency. Immediately thereafter the binder course of the terrazzo finish should be placed, making it 1 in. to 1⅛ in. thick. This binder or "filler" course should preferably be a 1:3 cement-sand-mortar. The sand should be clean and well graded. This binder course should be tamped into place and screeded to an even surface.

The placing of the finish is sometimes delayed, but better results are obtained if it follows immediately after the binder course is completed. The finish consists of a mixture of portland cement and marble, or stone chips or screenings, to which a little sand may be added. Some architects specify definite proportions of cement and chips, such as 1:3 while others merely specify that enough cement be used to fill interstices. This mixture is spread evenly to the proper thickness and rolled; then additional marble chips either of the same size or a little larger are spread over the surface and rolled in. Enough chips

should be used so that they will cover at least 85 per cent of the finished surface.

After the finish course has hardened somewhat (often at the end of 24 hours), but before it gets too hard, it should be ground to a smooth, even surface by a rotary rubbing machine, or by hand, using carborundum brick.

By using mineral coloring material and chips of different colors, shapes and sizes, an infinite variety of color and mosaic effects may be obtained. Borders and patterns of contrasting colors can readily be worked out by placing boards in the proper position when the main body of the floor is laid and later filling in the vacant places this provided with a mixture of the desired color. Joints that are hardly noticeable can thus be secured. Although much larger areas have been laid successfully, it is best to lay terrazzo blocks not over 10 ft. square in order to provide properly for expansion and contraction.

Concrete Dance Floors

A satisfactory surface for dancing is usually obtained by giving an existing concrete floor one of the following simple treatments. However, a more perfect surface will be obtained by first grinding the floor with a floor surfacing machine.

1. Liquid soap applied to a floor in the form of a lather and rubbed into the pores with a scrubbing brush will, after repeating the process, produce a uniform, smooth surface. An occasional application of powdered soap to a floor thus treated will keep it in fairly good condition for dancing. If the floor is somewhat rough and porous several coats of the soap treatment will be needed.

2. A mixture of parffin wax and turpentine may be applied to the floor in sufficient quantity only to fill up the pores. An excess of the material would produce a sticky film. Both turpentine and paraffin wax should be of a good grade and no more paraffin used than will be completely dissolved in the turpentine. After the turpentine has evaporated, that is, after the floor surface is dry, it should be treated with powdered wax in the same manner as for a wooden dancing floor.

3. Paraffin wax may be driven into a concrete floor by heating the floor and treating it with melted paraffin wax. The object of heating the floor is, of course, to obtain penetration of the wax. The turpentine in No. 2 above is used as a carrier to get the paraffin to penetrate into the concrete surface.

Colored Floor Finish

It is often desirable to produce a colored floor surface without resorting to special floor tile or terrazzo. Floors of this sort usually are not to be subjected to heavy abrasive traffic so that such weaknesses as may be introduced by the use of coloring material in the top, or wearing course, is not important. Obviously, the coloring matter should be confined to the top course only.

Only mineral coloring pigments should be used, as other pigments fade rapidly and reduce the strength of the cement to a marked degree. Mineral colors vary in quality and show a tendency to fade, depending on their quality.

The amount of coloring materials added should not exceed 5 per cent by weight of the cement for heavy traffic floors as larger quantities may affect the strength of the mortar or concrete to an injurious extent. For light foot traffic floors and for ornamental borders 10 per cent may be used and will produce deep shades. Different shades of color can be secured by varying the amount of coloring material or by mixing two or more colors.

Red oxides of iron produce the most permanent red tints. Venetian red should be avoided as it tends to run and fade. Manganese oxide is probably the best material for black, although a high grade of lamp black or carbon black is generally satisfactory. Common lamp black should not be used.

The intensities of shades produced by mineral colors will be slightly increased if the materials are mixed for a longer time than required for ordinary work. It has also been suggested that an application of a solution of magnesium fluo silicate or sodium silicate may be effective in setting the color in the concrete and checking a tendency of the color to fade.

Concrete Floor Treatments

The efficiency of a concrete floor surface depends upon the workmanship in laying the wearing course and upon proper protection during its early hardening by a covering which will keep the floor damp for at least

TABLE OF COLORS TO BE USED IN CONCRETE FLOOR FINISH

Amounts of pigment given in table are approximate only. Test samples should be made up to determine exact quantities required for the desired color and shade.

Colors desired	Commercial Names of Colors for Use in Cement	Pounds of color required for each bag of cement to secure Light Shade	Medium Shade
Grays, blue-black and black	Germantown lampblack* or	½	1
	Carbon black* or	½	1
	Black oxide of manganese* or	1	2
	Mineral black*	1	2
Blue shade	Ultramarine blue	5	9
Brownish-red to dull brick red	Red oxide of iron	5	9
Bright red to vermilion	Mineral turkey red	5	9
Red sandstone to purplish-red	Indian red	5	9
Brown to reddish-brown	Metallic brown (oxide)	5	9
Buff, colonial tint and yellow	Yellow ochre or	5	9
	Yellow oxide	2	4
Green shade	Chromium oxide or	5	9
	Greenish blue ultramarine	6	....

*Only first quality lampblack should be used. Carbon black is light and requires very thorough mixing. Black oxide or mineral black is probably most advantageous for general use. For black use 11 lbs. of oxide for each bag of cement.

two weeks. Experience has demonstrated that a wearing course composed of portland cement and a suitable aggregate correctly proportioned, mixed and deposited and properly protected after finishing will produce a satisfactory wearing surface, free from dusting.

If a wearing surface crumbles or dusts under moderate traffic, the wearing qualities of the floor can often be improved by the application of some hardener or treatment. Magnesium fluosilicate, sodium silicate, aluminum sulphate, zinc sulphate and various gums, soaps and paraffins are among the best known substances used to treat concrete floors.

Magnesium Fluosilicate Treatment.—The magnesium fluosilicate treatment consists usually in one or more applications of a solution of the silicate. The solution for the first application consists of about ½ lb. of the silicate dissolved in 1 gal. of water. For the second and subsequent applications the solution is made with about 2 lbs. of the silicate to each gallon of water.

Any number of applicants of the more concentrated solution may be given to the floor, depending on the condition of the floor and the apparent penetration obtained. In no case should one application follow in less than three-quarters of an hour after the preceding one. The surface treated should be kept wet with the solution for at least three minutes at each application so as to replace any the solution absorbed at once by crete. The primary object of of application is to secure nth of penetration as of the con atment.—A 20 the manne as great a de possible.

per cent solution of sodium silicate containing a small addition of an organic acid is applied in two or more coats 24 hours apart. Ordinarily the sodium silicate requires considerable time to dry properly so that the floor can be used. The sodium silicate treatment is, of course, inexpensive.

Commercial sodium silicate varies in strength from 30 to a 40 per cent solution. It is quite viscous and requires thinning with water before it will penetrate the floor. Ordinarily it will be found satisfactory to dilute each gallon of the silicate with 3 gal. of water. Each gallon of the resulting solution will cover about 200 sq. ft. of floor surface one coat. The floor should be thoroughly cleaned of all grease, plaster, dirt, etc., and should be thoroughly dry before the first application of the silicate solution.

Aluminum Sulphate Treatment.—The aluminum sulphate treatment consists in one or more applications of solutions of aluminum sulphate to the clean, dry surface. The solution is made up in a wooden barrel or stoneware vessel and the water should be acidulated with about 2 cc. of commercial sulphuric acid for each gallon of water. The sulphate does not readily dissolve and requires occasional stirring for a few days until the solution is complete. About ½ lbs. of the powdered sulphate will be required for each gallon of water and 1 gal. of the solution should cover about 100 sq. ft. of floor surface. For the first treatment the solution may be diluted with twice its volume of water. Twenty-four hours after this application the normal solution is used and 24 hours should elapse be-

tween additional applications of the solution.

Zinc Sulphate Treatment.—This treatment consists in the application of about 16 per cent solution of zinc sulphate with about 4½ per cent free sulphuric acid applied in two coats, the second coat being applied four hours after the first one. The surface should be scrubbed with hot water and mopped dry just before the application of the second coat. This treatment gives the floor a darker appearance than the original concrete.

There are a number of compounds of oils, gums, waxes, etc., which are sold as concrete floor hardeners. Pulverized iron mixed with sal ammoniac or some other oxidizing agent is also used both as an integral floor hardener and as a treatment for a concrete floor surface.

Admixtures.—There are on the markets a number of compounds which are widely recommended for inclusion in the body of the concrete. Instructions for the use of these com-[illegible]unds invariably call for many of [illegible]ethods and practices which are po[illegible] be essential for successful the n[illegible]s built without the in-known to [illegible]al compounds. Poor concrete floo[illegible]roper methods or clusion of integ[illegible]mpensated [illegible] workmanship or im[illegible] material materials cannot be co[illegible]g good by the admixture of an[illegible] other than those used in maki[illegible] concrete.

Floor Paints. — Decorative floor paints or coatings may be had in considerable variety from responsible manufacturers. Almost without exception these paints require that the floor be thoroughly clean and dry when the paint is applied. A fairly wide range of colors is available and, while these paints wear off under foot traffic, they are, in general, as permanent and wear resistive as the paints in use on wood floors.

Concrete Floor Coverings

In certain types of buildings, such as school, office, apartment, hotel and semi-public buildings, some covering on the floors is desirable regardless of the surface of the floor proper.

Experience has demonstrated that the coverings which come under the general classification of linoleums or relatively thin coverings should be attached or pasted to the floor over the entire surface. Manufacturers' specifications for laying linoleum or cork carpet over felt paper on concrete floors should be [illegible]

Where it is known beforehand that a linoleum or cork carpet type of covering is to be used, sufficient care should be taken to secure a surface sufficiently even and free from projections that the surface of the linoleum will be free from bumps and ridges and present an even surface. To accomplish this the floor finish known as a one-course floor is recommended. One steel troweling will usually be sufficient.

If the slab is composed of 1:2:3 mix, or richer, it will be a simple matter to work all of the coarse material into the slab by screeding the freshly placed concrete with a sawing motion of the strikeboard and floating with a wood float. In this process sufficient fine material, that is, cement and sand, will be brought to the surface to enable finishing to be done with a steel trowel without spreading any dry mixture of cement and sand or of dry cement alone on the floor for finishing purposes.

Where it is known beforehand that the heavier types of floor coverings will be used, steel troweling may be omitted, but in this case the freshly placed concrete should be carefully screeded to previously established grounds with a sawing motion of the strikeboard and the wood floating carefully done so as to be sure of a true surface free from projecting coarse aggregate or appreciable ridges or fins. Such floors should, of course, be provided with some means [illegible]astening the sheets of padding or [illegible]ng material used between the of [illegible]ugs proper and floor sur-deaden[illegible]ms are small a nailing carpets or [illegible] of the baseboard face. If the ro[illegible]ll be sufficient, strip at the botto[illegible] surface is around the rooms w[illegible] to pro-but if the unbroken floo[illegible] sur-very large, it will be necessar[illegible] vide inserts in the concrete ffoor face into which the floor covering may be buttoned. These inserts may be placed very easily after the floor has partially hardened so as not to interfere with the work of finishing.

If there is certainty that the floor will never be used to carry traffic directly on the concrete, wooden strips may be embedded in the concrete to be used to attach the floor covering.

Even if at some future time it is found desirable to uncover the floor and prepare it to receive traffic direct or to use the floor for dancing, a new floor topping may be put on the orig-

The Development of Skyscrapers in Germany

An Interesting Solution of the High Building Problem Described in the Journal of the American Institute of Architects

By DR. ING WALTER CURT BEHRENDT

In Europe, above all in the western industrial states, in England and in Germany, the erection of high buildings on the American model has long been the object of an interest which has increased considerably since the war. This is a consequence of the shortage of housing in the great cities and in the industrial centers, a shortage which has been aggravated by the post-war slump in building; and the erection of skyscrapers, it is thought, might prove most effective in relieving the housing shortage, inasmuch as the creation of new business areas in such giant structures would make it possible to evacuate numerous apartments now being used for business purposes. In England, the idea of erecting skyscrapers on the American model has found adherents mainly among members of the business world, whereas architects generally have so far raised objections, contending that the construction of skyscrapers would not be consistent with the best interests of city planning and housing.

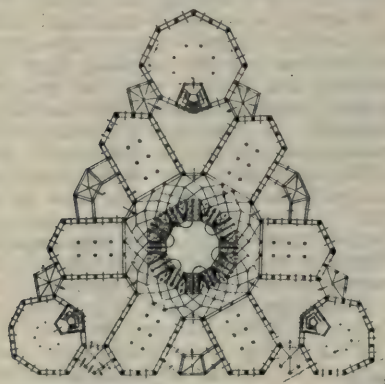


Fig. 1—Ground Plan of Skyscraper at Friedrichstrasse Railway Station at Berlin. Dr. Ing. Hans Soeder, Wetzlar, Architect.

On the other hand the skyscraper idea has met with general approval in Germany. The majority of German architects, in particular, have pronounced themselves in favor of introducing this type of building, which appeals to them as a new and attractive problem of monumental architecture. The idea has even been so enthusiastically embraced that the erection of skyscrapers for housing purposes has been recommended in some instances. However, the enthusiasm is being tempered by unfavorable economic conditions, and owing to the rising cost of building the construction of skyscrapers has nowhere been started. But the projects are numerous, architectural competitions for obtaining skyscraper plans having been held in almost all the great cities in the course of the last few years. These competitions, in which many leading architects have taken part, have yielded excellent and to some extent quite original results. These, in our opinion, are decided contributions toward the solution of this architectural problem, and may, therefore, claim the interest of foreign architects, more especially those of America, the homeland of the skyscraper.

In technical construction the German projects will seem familiar to American architects, because they imitate closely, in this respect, the American model. Imitation, in this case, is fully justified, for it seems hardly possible to devise anything better than the "steel cage construction" invented by American engineers, which carries all loads independently of the exterior walls, thereby relieving these of all the functions of support. On the other hand, as regards planning and architectural treatment, German architects have evinced rather remarkable creative originality, and have perhaps surpassed the American models by experimenting in various and entirely new directions.

The American Skyscraper Not a Model of Perfection.—In regard to planning, the American skyscraper, in its development so far, cannot be considered as a model of perfection. I believe that many members of the architectural profession in America are ready to concede this. That which is left to be desired is not so much the interior distribution of rooms, communication and circulation within

the building, or the arrangement of stairways and elevators; it is rather the architectural composition of the whole, notably, however, the disposition of the building plot. As a rule, the lot is either covered to its full extent or the building is grouped

Fig. 2—Project for a High Building in Dresden. Prof. Hans Poelzig, Berlin, Architect.

around one or several central courts, or is in the form of a group of towers. These arrangements, which reproduce the traditional planning of many-storied buildings and to which there is no objection if there are only five, six or seven stories, becomes very objectionable if applied to skyscrapers; it involves increased danger in case of fire—when wells or courts have the effect of smoke stacks, and it shuts out light and air from the lower stories.

German Planning of High Buildings.—German architects have recognized that it is not appropriate to group skyscrapers around central courts, as has been done in America. In order to avoid the inconveniences inherent in such arrangements, they have, therefore, endeavored to solve the problem of planning in a novel and fundamentally different manner. The solution sought has been determined by the natural desire to facilitate as much as possible access of light and air to these giant structures. The arrangement is that of wings projecting outward from the center of the block, permitting plenty of light and air to enter all rooms and therefore being especially advantageous for office buildings. Plans conceived according to this idea will, if highly developed, assume the shape of a star, stairways and elevators being arranged concentrically in the central part from which radiate the rather narrow wings with offices on both sides of an axial corridor.

For the further development of skyscraper construction this idea of planning promises to be important. In building on a star-shaped plan it will be possible to apply a straightforward method of construction. Buttressing rib-walls will give required stiffness to the central structure. Various static solutions are possible, and accordingly various constructive types may be evolved. The walls of the projecting wings may be built as inflexible bodies (producing the type

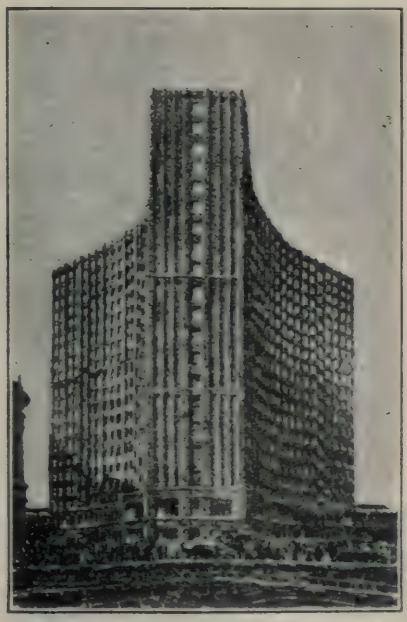


Fig. 3—Project for a Skyscraper in the Friedrichstrasse, Berlin. Prof. Hans Poelzig, Berlin, Architect.

shown in Fig. 1), or a system of interpenetrating trusses may be constructed, resulting in a vertical structure in the center with lateral setbacks. Other systems of construction are also possible, each productive of other forms.

The Architectural Form of Skyscrapers.—These projects will exemplify how construction, if logically developed, may produce new architectural forms, capable of strong monumental effect without resorting to the current elements of classical architectural decoration. In giving architectural form to the skyscrapers, such tendencies have been very prevalent in America—contrary to the constructive conception of architecture which is so generally observed in the forms of buildings for industrial purposes, such as factories and workshops, silos and grain elevators. The architecture of the American skyscraper has closely followed the traditions established at the Ecole des Beaux Arts at Paris, utilizing the forms of decorative architectural expression in comomn usage, such as columns, pilasters, ornaments, etc. These great edifices thus frequently take the shape of enlarged Renaissance palaces, the three sub-divisions of basement, superstructure and crowning cornice with attic, determining the scheme of the elevations, while the traditional decorative forms are applied, only enlarged in scale and somewhat coarser. The result is those tremendous piles of stone that are to be found in all American cities, exhibiting "parades of columns" and motives of temple architecture towering one upon another in a somewhat awkward manner, impressive more through bigness of scale than through really monumental effect.

Fig. 4—Ground Plan of Skyscraper of Iron and Glass to Be Erected in Berlin. L. Mies van der Rohe, Berlin, Architect.

Purpose of Building Determines Its Form.—German architects, on the other hand, have endeavored to make the purpose of the high buildings determine their form—as may be illustrated by the pictures. In the projects here reproduced the peculiarity of the purpose and the properties of the materials have dictated the law, according to which the form has been developed. Consequently there has resulted a structure of a new and formal aspect, independent of academic, classical tradi-

tions and expressive only by virtue of its own intrinsic character, visible in the ponderousness of its mass and in the vigor and peculiarity of its appearance. This form voluntarily renounces the empty pompousness of architectural ornamentation borrowed from the styles of the past, depending for expression not on "the beautiful facade" but on impressive grouping and towering of masses, on harmony of proportions, on forceful effects of interesting outlines. These projects reveal the same principle of composition which we recognize in the monumental civic structures of medieval cities, in the imposing fortifications, defensive towers, city gates and granaries. As is well known, the cost of ornamental accessories was not added to those buildings; nowhere do they reveal superfluity, or a form incongruous with the purpose of the building. One who has seen such structures must admit that they appeal through an expressive and almost matchless vigor. Their effect, impressive as it is, has been obtained through the most primitive means of architectural expression, through appropriate grouping and such a well-balanced disposition of masses as to enhance the rugged strength of the general appearance.

Skyscraper Problem and City Planning.—Finally, there are offered some general observations on the skyscraper problem from the viewpoint of city planning.

Whatever reasons we may assign for the fact—the narrow island or high land values—New York offers the greatest experience and field of study. High buildings have been fairly well spread over large areas on the narrow island of Manhattan, in preference to extending buildings of moderate height over far larger areas. In the beginning this was done without any regard for the esthetic effects of street perspectives or the urban scene in general, nor did the traffic problem enter into consideration; in short, the elements and viewpoints of city planning were entirely neglected. Moreover, the erection of these buildings was, at least in the beginning, subject to little or no regulation through zoning laws or through uniform height limtation, as is usual

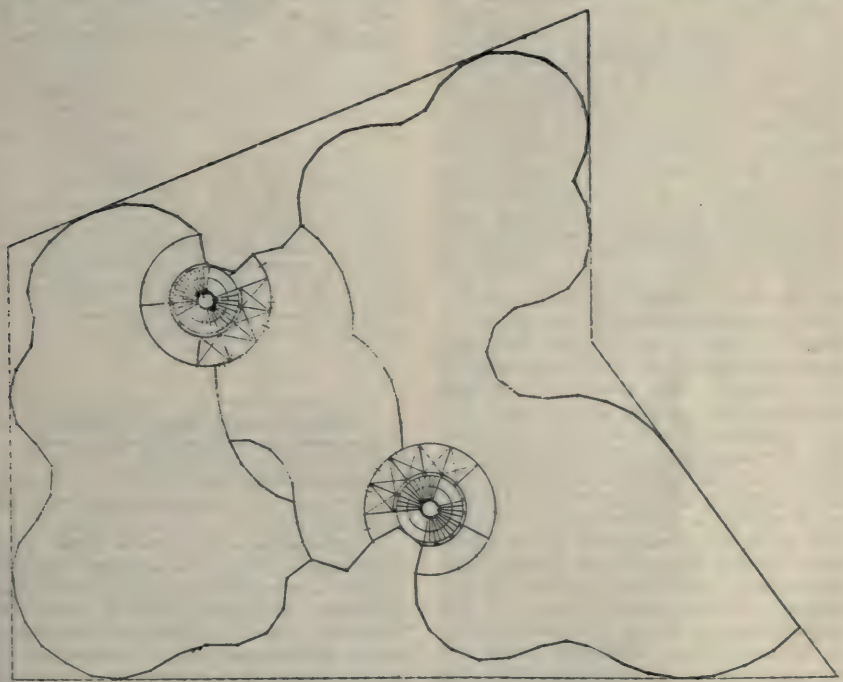


Fig. 5—Project for a Skyscraper of Iron and Glass. L. Mies van der Rohe, Berlin, Architect.

in Europe. Consequently, high buildings were erected wherever there was a profitable opportunity for speculation.

Similarly, needs growing out of various untoward circumstances have caused the increased interest which the American type of building has aroused of late in Europe, more especially the industrial countries of the old continent, where the housing shortage has followed hard upon the cessation of building. However, such disregard for requirements of city planning as may be excusable on the virgin soil of a colonial empire, would be indefensible in Europe, where history and urban traditions have determined the peculiar conditions of old regions of culture, and where the requirements of planning are a primary concern. European cities, which have grown and developed through centuries, possess an historical character which most decidedly demands that skyscrapers should be erected only on carefully chosen plots. Otherwise beautiful urban compositions might be frivolously destroyed, or new and foreign elements might, at least, intrude in such a manner as seriously to impair the effect of historic groups of buildings. The erection of a high building, introducing a new scale and new proportions, is certain to affect the surroundings, near and far, and will, under all circumstances, modify the character of street vistas as well as of the whole urban scene. Taking this into consideration, it seems likely that "tower houses"—in great German cities developed around an old center— will be erected mainly in the outer districts owing to the difficulty of bringing their enlarged scale into harmonious relation with the old buildings of the "Altstadt." The project for the "Kaufmannshaus" (Merchants' House) in Cologne, to be erected in the immediate vicinity of the Cathedral, represents a bold attempt to place a skyscraper in the old center.

At all events, the erection of high buildings in German cities will not be left to the uncontrolled activity of individual builders. On the contrary, the number of such buildings must be limited, and their erection will be permitted only on plots which satisfy certain conditions and are of distinctive importance in the urban ensemble. Besides, the increase of land values which the erection of skyscrapers will cause, necessitates special legislative measures. In Germany it has been proposed that plots on which skyscrapers can be erected through exemption from the general building regulations, should pass to the community after thirty, fifty or ninety years, without any compensation. It should be considered absolutely inadmissible that a tall, bulky building be elected on a street barely wide enough for adequately serving normal circulation; such a building, besides depriving its neighbors of air and light, will cause traffic congestion, and in planning for such structures the needs

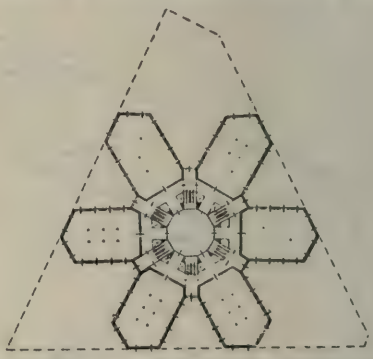


Fig. 6—Plan of 20th Floor of Skyscraper at Friedrichstrasse Railway Station, Berlin.

of circulation should always be considered as an integral part of the problem.

Combination of House and City Planning.—Fig. 7 illustrates an attempt at combining house and city planning in a constructive way, the building projected being a skyscraper on a star-shaped plan. According to the project the structure is to be erected at the point of intersection of several streets, the general arrangement being such as to allow traffic to proceed in radial directions between the wings of the building. In these intermediate spaces parking places for vehicles have been provided, thus anticipating the congestion bound to occur in the morning and late afternoon hours.

Obviously, the particular city planning problem which the erection of skyscrapers presents can be satisfactorily solved only in a constructive way and not by erecting them at random. In every city there are only certain points at which skyscrapers

can be so placed as to fit into the general scheme. If erected at such points, recognized as suitable in a technical way, these high buildings, centers of circulation, will fulfill an organic function in the urban entity, and will, accordingly, appear to occupy their right place in the general scene of the city. Such being the case, it does not seem worth while to over-emphasize the more or less academic city planning conceptions based on esthetic traditions. The somewhat sentimental talk of sky-line effects and of "architectural accents" seems futile. As regards creative value, such esthetic theories are on a par with the decorative paraphernalia of academic paper architecture, orders, pilasters, cornices, and the rest. Logical planning and construction, according to purpose and practical requirements, have been capable of originating new architectural forms. Likewise the planning of skyscrapers in a city presents a problem of architectural propriety, the logical, constructive solution of which may result in creating an artistic urban unity.

Fatigue Properties of Steel

The U. S. Bureau of Standards is carrying out an investigation on the fatigue properties of various woods and metals and in connection with this work 26 specimens of 3½ per cent nickel steel have been tested in the rotating beam fatigue machine by the load deflection method. The results are consistent for the different heat treatments to which the metal had been subjected. Fatigue values of from 50 to 55 per cent of the ultimate strength were obtained when the proportional limit was above that of the fatigue limit. When the proportional limit of the material was less than 50 per cent of the ultimate strength, the fatigue limit was less than the proportional limit. Fatigue tests by the load deflection method have also been made in a rotary beam fatigue machine on three specimens cut from a Thermit-welded rail joint. The fatigue limit averaged 31,500 lb. per square inch with an average ultimate strength of 57,445 lb. per square inch, the average percentage of the fatigue limit to the ultimate strength was 54.9.

Appearance of Completed Stone Work Contingent Upon Its Treatment at the Building

Importance of Proper Storage on Building Site and Reasonable Protection After It Is Set Pointed Out in Stone

By WALTER W. DRAYER,
President International Cut Stone Contractors' and Quarrymen's Association, Inc.

Recently on a visit to Detroit, the writer had the opportunity of observing two large jobs in the course of erection that presented a striking illustration of the fact, that although cut stone is delivered at the building in perfect condition, its appearance in the building depends upon the manner in which it is set and the protection accorded it until the exterior of the building is completed, cleaned and pointed.

An excellent Example of Proper Handling of Cut Stone.—One of the jobs referred to is the new Masonic Temple, an all stone building of classic and pleasing design. The stone in this building is clean; it is faultlessly set with joints raked out to a uniform depth to be pointed when the exterior is completed. Even in its unfinished state it stands out resplendent among beautiful surroundings with just enough variations in color to give it that mellowness that is so pleasing to the eyes. It is a building of which the architect, the Masonic order, the City of Detroit, the cut stone contractor, and the stone industry may justly feel proud—an enduring monument of stone. It is proof positive that if cut stone is to merit its worth, and adorn our buildings with the beauty nature gave it, it must be handled and set at the building under the supervision of a competent setting contractor, and, after being set in place, accorded proper protection until the exterior of the building is completed.

The other job.—The other job, a public school generously trimmed with cut stone, presented a sorry sight. In this building the abuse to which the cut stone was subjected was almost criminal. The stone was delivered to the building in perfect shape and as clean as the day it left the quarry. It was not set by, nor under the su-

pervision of, the cut stone contractor; his contract ended upon the delivery and proper storage of the material on the building site. Projecting cornice and belt courses of this stone were left unprotected after being set in the building. Waste mortar lay 2 to 6 in. deep on these projections, while here and there the arrises were sprawled and chipped by falling brick, etc. Ordinary lime mortar laying on exposed projections affords rainy and damp weather a splendid opportunity to spread a stain over stone work that is difficult and sometimes impossible to remove, but in this instance a still more effective staining influence was carelessly permitted to enter into the aforementioned abuse with which the stone was treated. Although the exterior walls were of brick and stone, the floors were of concrete, the slabs being poured after the walls were up to the floor level. In the pouring of these floors, seepage, and in places, even the aggregate flowed out over the exterior walls and finally landed on the stone projecting courses, leaving a stain which only the hot summer suns of many a day, can, in time, bleach out. All of this could have been prevented. A builder wouldn't think of permitting a man with hobnailed boots to walk over a finished hardwood floor, nor workmen to spit tobacco juice on a marble wainscot or staircase. If other work was going on around finished work of this kind it would be covered up and protected. Then, why will he permit cut stone, which is in finished product in the same sense as the hardwood floor or marble staircase, to become the catch-all for mortar, brickbats, etc. Cut stone when properly treated dignifies, embellishes and enhances the value of a building. When abused it needlessly presents an unsightly appearance, a provocation to the architect, a disappointment to the owner, a business handicap to the cut stone contractor, and, finally, a rank injustice to the most beautiful and stable building material with which nature endowed us.

Proper Storage of Cut Stone.—Cut stone when delivered to the building site should be properly stored. It must not be dumped upon the clay or sod, where dampness can stain it and where workmen or trespassers can walk over it. Sills, belt course, coping, ashlar, etc., should be stored in piles with sills of soft wood not less than 2 in. thick placed upon the ground to receive the first course and with 1 in. strips of soft wood between each subsequent course. The backs of the stone should form the outer edge of the pile, and the several pieces in each course be placed face to face. If this pile is to stand some time before the stone is set it should be protected against injury by trucks delivering material around it, by a barricade. Cornice, lintels, etc., that are too heavy to store in piles, should not be slid off the truck onto the ground. They should be placed on skids out of the way of the movement of other material about the building, and far enough away from the walls of the building to be out of the path of falling mortar, brick clippings, etc. Small stone such as arch stone, jambs, brackets, etc., of irregular shapes, that cannot be stored in piles, should be stored upon a floor of boards, at a safe distance away from the building, and truck drivers should not be permitted to unload brick and other material around them.

Stone after it is set in the building must be protected. Projecting courses should be covered with boards or heavy building paper. Jambs at openings through which building material is being moved should be boxed in. Mortar or concrete must not be mixed within a range of finished walls that will permit of the splashing of same. Cut stone has not universally been given the treatment in handling at the building and setting that it requires.

Iowa State Board of Engineering Examiners.—This board is now organized with the following membership:

Seth Desn, Chairman; address, Glenwood, Ia.

L. M. Martin, Vice-Chairman; address, Atlantic, Ia.

Alvin LeVan, address, Des Moines, Ia.

B. F. Fleming, address, Iowa City, Ia.

C. S. Nickols, address, Ames, Ia.

Successful Central Purchasing.—In recommending the adoption of a centralized purchasing ordinance, Frank C. Perkins, commissioner of public affairs of Buffalo, reports that the saving on the centralized purchase of 304,000 gallons of gasoline used last year by that city would pay for the operation of a central purchasing department.

Formulas for Computing Economies of Labor-Saving Equipment

Committee Report Presented at Spring Meeting of American Society of Mechanical Engineers, Montreal, Canada, May 28 to May 31

The problem presented is one of comparative costs. The tendencies in current practice which it is desired to correct are simply lack of consistency in treating the debit and credit items involved. Incidental items, such as interest on investment, taxes, maintenance, depreciation, obsolescence, etc., in other words, "fixed charges" or "burden," are currently accounted on the debit side when calculating the costs of substituting mechanical processes for manual ones. It seems, however, to have been unusual to make any contingent addition in calculating the monetary value of labor saved by improved methods.

In principle the desired formula represents simply a mathematical expression of such debit and credit items as are involved in the proposed new method, or process, as compared with previous practice. In highly organized and thoroughly systematized industrial practice, however, direct expenditures and direct economies are frequently of less importance in their monetary value than related incidental expenditures and economies. For instance, labor is employed in the factory for processing a raw material, which is thereby enhanced in value and becomes the factory's product. As a rule the total cost of the process will consist of, say, one part "direct labor" (labor which can be charged directly to a single process, or part of the product) and from one-half to three parts "fixed charge," "burden," or operating charge, consisting of "indirect labor" (labor which is of general utility and not chargeable directly), and such items as superintendence, employes' liability, welfare activities, maintenance of buildings and machinery, fuel, supplies, insurance, depreciation, taxes, accounting, etc.

Problem One of Economics.—The real problem in composing a formula, therefore, is not one of mathematics, but of economics. Not only should there be added to each dollar expended for improved equipment a suitable incidental amount (in percentage of the capital invested) to cover fixed charges or burden, but also a suitable incidental addition (in percentage) should be made to each dollar's worth of labor saved, as its proportion of "burden" saved. The extent of the expenditure for items accounted as burden will usually bear some fairly proportional relation to the amount of labor performed.

When calculating the cost of the finished product, if an improved process or equipment affects the amount and hence the cost of the "direct labor," then, for the most accurate results, the burden should be applied to labor saved at the same rate as labor used.

For the purpose of ascertaining the cost of the product, non-productive labor, as a part of burden, should not be considered as subject to any contingent addition for burden. Yet for certain classes of accounting, particularly where comparative economies are being considered, non-productive labor may carry all items of burden that are chargeable to direct labor, except that it carries no contingent addition for its own class of indirect labor. It entails superintendence, employes' ilability, welfare work, penalties for overtime and holidays, capital for payrolls, housing, heating and lighting, with the incidental maintenance, taxes, depreciation, and other charges, in the same way as direct labor.

Since a new process must of necessity be considered in comparison with an established process, no "burden" need be considered in respect to the labor used in either case, because the burden charge per unit of labor in one process will offset an equal unit of labor in the other process. The difference in labor required, however, must, in the interest of accuracy, be subject to its appropriate addition for "burden." For this class of cost accounting the cost department of an industry should ascertain the proper percentage to add for burden on both "productive" and "non-productive" labor.

Handling materials is practically always an important item of cost in

manufacturing. With a complex product it would be difficult to charge handling costs to individual materials; and it is usually accounted as "non-productive" labor and distributed to various items of product, through an addition in the way of a percentage on direct labor, or an equivalent method, in common with other items of "burden." Here we have an example of labor expended in handling miscellaneous materials which would be accounted as "non-productive" labor.

If, however, we consider the employment of labor in transportation, in the handling of miscellaneous materials, it would naturally be accounted as "direct" labor, since it accomplishes an important and definite step in the process of transportation, and should therefore be subject to its pro rata share of all fixed charges whether it is labor used or labor saved by an improved process or by the substitution of mechanical process.

In the opinion of the committee, current practice which usually takes no account of "fixed charges" or "burden" on the excess of labor used by one process or on the labor saved by another process, represents a grave error in any analysis of comparative costs. Also in some cases where "burden" is added to "direct labor" in calculating comparative vosts, it is omitted entirely where the labor is accounted as "non-productive," or indirect.

Based upon these considerations the following rule for setting a value upon labor saved by improved process has been evolved:

Whatever valuation is arrived at in cost accounting as the cost per unit of labor used in production, also establishes the value per unit of labor saved by an improved process. For simplicity, no monetary value need be placed upon labor employed in comparative processes, except upon the amount of difference in labor required at the current rate paid, plus "burden" or an equivalent.

Other items of cost should in like manner be accounted at the same rate as for similar items in making up the cost of product.

In calculating comparative cost a new item is introduced which never becomes a factor in regular cost accounting, namely, the monetary value of increased production. The profitableness of any industry stands or falls upon the relation between total cost of production and total volume, and hence value, of product.

An increase of product with a given equipment will affect the spread between cost and the market value of product just as vitally as an equivalent reduction in some or all of the items of cost. Accordingly, no system of comparative cost accounting can pretend to even approximate accurary which does not place a suitable valuation upon increased productivity.

In placing a valuation upon increased productivity it should be borne in mind that in any industry the volume of product required to just meet the costs of the plant and a given organization affords no profit; also that any product above that amount is obtained without any manufacturing cost whatever; hence the rule.

In a comparative accounting increased production will always carry a higher value than that attached to normal production.

The Formulas.—The committee therefore unanimously recommends the following methods:

Let:

Debit Items

A = percentage allowance on investment

B = percentage allowance to provide for insurance, taxes, etc.

C = percentage allowance to provide for upkeep

D = percentage allowance to provide for depreciation and obsolescence

E = yearly cost of power, supplies, and other items which are consumed, total in dollars

Credit Items

S = yearly saving in direct cost of labor in dollars

T = yearly saving in fixed charges, operating charges or burden in dollars.

U = yearly saving or earning through increased production, in dollars

X = percentage of year during which equipment will be employed

I = initial cost of mechanical equipment

Results

Z = maximum investment in dollars justified by the above consideration

Y = yearly cost to maintain mechanical equipment ready for operation

V = yearly profit from operation of mechanical equipment.

Then

$$Z = \frac{A + B + C + D}{(S + T + U - E)X} \quad \text{.....[1]}$$

$$Y = I(A + B + C + D) \quad \text{.....[2]}$$

and $$V = [(S + T + U - E)X] - Y \quad \text{.....[3]}$$

Feeling that handling machinery, even if left idle a large part of the year, would probably require, under most conditions, approximately the same repair through deterioration as though in use, the committee makes no deduction for such lack of use in the estimated cost of upkeep C. If

greater accuracy be considered necessary, use C multiplied by X in place of C in the formulas.

Applications of the Formulas.—As an example of an application of the formulas, assume that the handling of miscellaneous materials about a factory which has formerly been done by four men receiving $3.50 per day each, or, allowing 300 days per year, at an annual direct cost of $4,200, can be done by one man operating an electric storage-battery industrial truck at a direct-labor cost of $1,050 per year, thus effecting a saving at the rate of $3,150 per year in direct-labor cost.

Assume also that through the greater promptness in moving materials and the more continuous operation of machines there is an increase in earnings, due to increased production, valued at $650 per year; also that the labor involved, being accounted as "non-productive," carries a fixed charge or burden of 10 per cent. In actual practice the plant operates 240 days per year or 80 per cent of the time. The various factors therefore, are estimated as follows:

$A = 6$ per cent $\quad S = \$3150$
$B = 4$ per cent $\quad T = 315$
$C = 20$ per cent $\quad U = 650$
$D = 25$ per cent $\quad X = 80$ per cent
$E = \$450$

$$Z = \frac{(\$3150 + \$315 + \$650 - \$450) \times 80}{55} = \$5331.$$

This indicates that equipment costing any sum below $5,331 will earn some profit above interest on investment and maintenance.

Assume that an electric storage-battery industrial truck will meet the conditions stated and that its cost will be $2,200. Then the yearly cost to maintain equipment ready for operation, exclusive of labor, will be expressed by the formula, $Y = I(A + B + C + D)$ or $2200 × 55 per cent = $1210. Then the profit from operation of the mechanical equipment, according to [3], becomes ($3150 + $315 + $650 — $450) × 0.80 — $1210 = $1722.

The profit V, or $1,722, represents an annual earning upon the initial investment, over all items of cost, of over 78 per cent.

If, however, our example be applied to handling cargo at a railroad or marine terminal where the labor is productive labor and subject to all fixed charges as burden, an important difference in result will be had, indicating the importance of the factors T and U, and the necessity of placing proper values upon them if reliable results are to be had.

As such an example of an application of the formulas, assume that in handling miscellaneous cargo at a marine terminal, work which has formerly been done by four men receiving 3.50 per day each, or, allowing 300 days per year, at an annual direct cost of $4,200, can be done by one man operating an electric storage-battery industrial truck at a direct-labor cost of $1,050 per year, thus effecting a saving of $3,150 per year in direct-labor cost.

Since this labor is productive labor, it will bear its pro rata share of all fixed charges, estimated at 50 per cent and to be added to the direct-labor cost, representing a further saving of $1,575 on account of labor. Also that, through the greater promptness in unloading and loading vessels, 5 per cent more ships can be accommodated, accounting for 15 days' extra use of the pier yearly. Assuming the investment in the pier to be $1,000,000 and interest, taxes, etc., at 10 per cent, we have a credit item of 0.5 per cent to be divided, say, between 20 electric trucks, or $250 per truck per annum.

Applying the formulas as in the previous example, we have

$$Z = \frac{(\$3150 + \$1575 + \$250 - \$450) \times 80}{55}$$
$$= \$6582 \text{ permissible investment.}$$

The yearly cost of operation is $Y = $2200 × 0.55 = $1210 as in the previous example. The profit above maintenance charges, V, will then be ($3150 + $1575 + $250 — $450) × 0.80 — $1210 = $2410.

The profit $2,410 represents an annual earning of nearly 110 per cent upon the investment in this case in place of 78 per cent in the previous example, all factors having been upon exactly the same basis except T (yearly saving in fixed charges) and U (yearly saving through increased production).

The following summary shows the relative value of the same device applied to two conditions, first, where the labor employed in the work is unproductive as regards producing an article of manufacture, and, second, where the labor used produces the salable commodity, in this case material handling.

	Case 1 Handl. in Factory	Case 2 Handl. in Marine Terminal
Cost of equipment	$2200	$2200
Z, investment justified	5331	6582
Y, yearly maintenance	1210	1210
V, profit from installation	1722	2410
Per cent return on investment	78	110

A study of this comparison indicates that with suitable values given to the factors the formulas proposed show not only the advantages otbainable under various conditions, but also that a device may be much more valuable per dollar invested in one industry than in another. The difference shown would have been much more pronounced had regular stevedores' wages been used for the wages of the man at the marine terminal.

Crystalline Structure of Ferrite

Ferrite is the metallographic constituent, iron, which forms the basis of all steels. Hence, any advance in our knowledge of its characteristics is of interest and also of some possible technical importance. The crystal grains of ferrite often show a peculiar network within the individual grains after various types of etching for revealing the microstructure. This gives the material the appearance of being of a very fine grained structure which, if true, would greatly affect the properties of the material.

During the past month the U. S. Bureau of Standards has devoted some time to the study of the phenomenon which has been noted by other observers, although no explanation of its nature has ever been suggested. The work has not yet been completed, but the results so far obtained indicate that this peculiar feature in the structure of ferrite is not related to the ordinary crystalline structure as it exists at room temperatures. When ferrite is heated sufficiently, it undergoes an allotropic change. Some evidence has been obtained indicating that when the iron is cooled from a high temperature all evidence of the structural condition existing at that temperature is not entirely erased, but persists as a pattern superimposed upon the ordinary structural arrangement. When the iron is reheated to a sufficiently high temperature, although considerably below the temperature at which the allotropic change takes place, the characteristic network previously mentioned results, but upon continued heating this is wiped out as equilibrium is obtained. Further work is in progress to show more clearly in what these changes consist, but it is evident from what has already been accomplished, that they are quite different from the usual processes of recrystallization and grain growth.

Wholesale Prices, 1890 to 1922

The course of wholesale prices from 1890 to 1922 is reviewed in Bulletin No. 335 recently issued by the Bureau of Labor Statistics of the United States Department of Labor, Washington, D. C. This bulletin, which is the twentieth of a series of annual reports on wholesale prices published by the bureau since 1902, contains monthly detailed price information for 1921 and 1922 and yearly information back to 1890. Four hundred and fifty-four commodities or series of price quotations are included in the tables of prices for recent years.

A brief history of the wholesale price investigations of the bureau is presented in the introduction to the bulletin, followed by an explanation of the method used in constructing its weighted index numbers, which are built on 404 commodities or price series. Statements showing the character and sources of the price quotations, the number of commodities classified as to frequency of quotations (whether weekly, monthly, or average for the month), and the number that increased or decreased in average price from 1921 to 1922 are included. Tables of index numbers for the various groups of commodities and for all commodities combined are given for all years from 1890 to 1922 and all months from 1913 to 1922.

The bulletin briefly reviews price movements during 1922 and during the 10 years since 1913. Numerous charts assist the reader in following the prices of important commodities and groups of commodities over the period. Appendixes to the report contain statements showing the weights used in constructing the index numbers, the relative importance of commodities as measured by their wholesale values in 1922, and index numbers of building material prices, by sub-divisions, 1913 to 1922.

There is also appended a chapter reviewing the course of wholesale prices in other countries.

Monthly Statistics of the Building Industry

The accompanying tabulations are taken from the Survey of Current Business, a publication of the U. S. Department of Commerce. They show (1) the building contracts awarded by thousands of square feet, and thousands of dollars, (2) the index numbers for building contracts awarded, (3) the building material price index for frame and brick houses, (4) the cost index for constructing factory buildings, and (5) the index numbers of wholesale prices for structural steel, iron and steel, composite steel and composite finished steel.

The figures on building contracts are based on data compiled by the F. W. Dodge Co., covering small towns and rural districts as well as large cities in 27 northeastern states. Prior to May, 1921, the building figures covered 25 northeastern states and the District of Columbia. The states are those north and east of, and including, North Dakota, South Dakota, Iowa, Missouri, Tennessee, and Virginia, together with portions of eastern Kansas and Nebraska. Beginning May, 1921, North Carolina and South Carolina were added to the list, but this addition is stated to have little effect upon the total.

The price indexes for frame and

	Grand Total Building Contracts		Index Numbers		Building Material Price Indexes		Cost Index	Wholesale Prices Index Numbers			
Year and Month	Thousands of sq. ft.	Thousands of dollars	Sq. ft.	Value	Frame house	Brick house	Factory building costs	Structural steel beams (Pittsburgh)	Iron and steel	Composite steel	Composite finished steel
1913 monthly av.	.....	$71,475	.....	33	100	100	.....	100	100	100	100
1914 monthly av.	.....	60,020	.....	28	.....	.....	100	83	87	88	86
1915 monthly av.	.....	78,341	.....	36	.....	.....	.....	93	94	95	92
1916 monthly av.	.....	113,082	.....	53	.....	.....	.....	177	154	163	161
1917 monthly av.	.....	134,086	.....	63	.....	.....	.....	269	266	259	252
1918 monthly av.	.....	140,770	.....	65	.....	.....	.....	202	215	220	213
1919 monthly av.	46,683	214,990	100	100	.....	.....	.....	174	191	193	188
1920 monthly av.	33,491	211,102	72	98	.....	.....	.....	187	249	211	222
1921 monthly av.	32,267	196,648	69	91	.....	.....	179	131	155	156	152
1922 monthly av.	47,745	279,410	102	130	182	186	170	115	144	134	134
1921											
January	15,513	111,608	33	52	.....	.....	.....	.....	.....	.....	.....
February	16,807	100,677	36	47	.....	.....	.....	.....	.....	.....	.....
March	26,709	164,092	57	76	.....	.....	.....	.....	.....	.....	.....
April	34,494	220,886	74	103	.....	.....	.....	.....	.....	.....	.....
May	35,751	242,094	77	113	.....	.....	176	146	165	170	166
June	35,738	227,711	77	106	.....	.....	172	146	159	165	159
July	31,717	212,491	68	99	.....	.....	167	139	145	153	148
August	35,246	220,721	76	103	.....	.....	161	123	137	144	141
September	41,702	246,186	89	115	.....	.....	160	123	134	138	136
October	40,436	222,480	87	103	.....	.....	157	116	135	134	134
November	37,818	192,311	81	89	166	173	154	106	132	133	128
December	35,272	198,518	76	92	173	179	153	99	129	130	127
1922											
January	30,261	166,320	65	77	174	179	152	99	127	126	124
February	30,061	177,473	64	83	169	174	152	99	125	124	121
March	51,957	293,637	111	137	169	173	152	96	125	122	122
April	58,146	353,162	125	164	168	172	152	99	131	126	125
May	59,639	362,590	128	169	173	176	157	106	139	127	127
June	60,526	343,440	130	160	178	181	165	106	140	129	130
July	51,705	350,081	111	163	181	184	171	109	142	130	131
August	54,019	322,007	116	150	189	193	174	116	151	137	138
September	44,275	271,493	95	126	193	197	190	137	166	146	146
October	46,806	253,137	100	118	196	199	192	141	166	149	148
November	46,946	244,366	101	114	196	201	192	136	160	149	146
December	38,603	215,213	83	100	192	198	192	132	154	149	147
1923											
January	38,947	217,333	83	101	195	199	192	132	156	151	149
February	41,611	229,938	89	107	198	201	197	139	162	158	157
March	64,920	333,518	139	155	209	209	197	146	171	165	163
April	64,527	357,475	138	166	206	209	204	172	179	174	169
May	60,430	374,400	129	174	212	214	204	174	180	176	168
June	46,344	323,559	99	150	212	215	208	169	175	170	168

brick houses are from the U. S. Department of Commerce, Bureau of Standards, Division of Building and Housing and Bureau of Census, and are based on prices paid for material by contractors in some 60 cities of the United States. The prices are weighted by the relative importance of each commodity in the construction of a 6-room house.

The index number for constructing factory buildings is furnished by Aberthaw Construction Co., and is designed to show the relative changes in the cost of constructing a standard concrete factory building. The company believes that the year 1914 gives a normal base and that July, 1920, with an index number of 265, represented the peak of costs.

The index numbers of wholesale prices for structural steel, etc., are obtained as follows: The prices for structural steel beams are the average of weekly prices from the U. S. Department of Labor, Bureau of Labor Statistics. The figures for iron and steel are the average of weekly prices compiled by the Iron Trade Review on the following 14 products: Pig iron, billets, slabs, sheet bars, wire rods, steel bars, plates, structural shapes, black galvanized and blue annealed sheets, tin plates, wire nails, and black pipe. Pig iron average in turn is average of 13 different quotations.

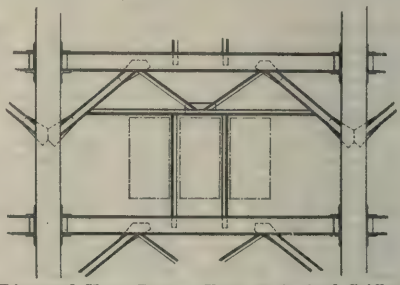
The figures for composite steel are compiled by the American Metal Market and represent the average price per pound of steel products weighted as follows: 2½ lb. bars, 1½ lb. plates, 1½ lb. shapes, 1½ lb. pipe, 1½ lb. wire nails, 1 lb. galvanized sheets, and ½ lb. tin plate.

The composite price of finished steel products is compiled by the Iron Age. It includes: Steel bars, beams, tank plates, plain wire, open-hearth rails, black pipe, and black sheets. These products, according to the Iron Age, constitute 88 per cent of the United States output of finished steel.

Traffic Over Michigan Ave. Bridge, Chicago.—It has been found by actual count that the flow of traffic over the Michigan Ave., Link bridge in Chicago, exceeds that of Fifth avenue, New York, by nearly fifty per cent; that 53,014 vehicles cross the span between 7 a. m. and midnight, or an average of 3,118 an hour, with a maximum of 4,360 during the rush hour.

Special Stiffening of Tokio Steel Frame Buildings

Many studies have been made by Japanese engineers to permit them to design steel frame buildings which would be proof against earthquake shock. In general, the tendency has been to make a building which would be sufficiently rigid in itself to move as a single unit without distortion among the several parts. It is reported now that all of the steel frame buildings in Japan went through the earthquake structurally undamaged, and it is believed also that most of the important ones were saved from the conflagration by the wide open space of the station plaza which faced the Marunouchi Building. In the Iron Age for Sept. 13, Mr. H. V. Spurr, of Purdy & Henderson, engineers, New York City, who designed the steel work for the Marunouchi, the Japan Oil, and the Nippon Yusen



Diagonal Knee Braces Form Principal Stiffening Element in Each Wall Panel.

Kaisha Buildings in Tokio, points out the essential difference in construction details between the Japanese and the American designs.

The main difference lies in the columns, the connections of the beams to the columns, and particularly in these elements as they occur in the outside walls of the buildings. The spandrels, in particular, are unusually heavy and are fitted with diagonal bracing, tying them to the columns in a way calculated to prevent any relative movement between the two. The column splices, which occur, as in American practice, at every second floor, are exceptionally heavy and in some cases are as long as a story height. In these exceptional cases as many as four splice plates, with close to 200 rivets through

them in four rows, are fitted on each side of the column.

All of these buildings are erected on the sand underlying Tokio. They are all carried on piles of 40 to 60 ft. in length and in some cases the piles under individual columns occupy so much area that the piling becomes almost continuous under portions of the building. The footings of stone concrete, with a large amount of steel reinforcing, are poured around the heads of the piles and the individual column footings tied together by reinforced concrete beams, forming in effect an enormous mesh with space between members equal to the column spacing. The reinforcing rods in these intercolumn members, which are designed to act as both ties and struts, are carefully anchored around the column bases before the concrete is poured around them.

All three of the buildings mentioned are similar in general structural design, but the Marunouchi Building, covering a far larger ground area than either of the others, and having in consequence much greater inherent stability, was less heavily braced than the others.

Construction consisted in each case of short span slabs of reinforced concrete, usually 4½ in. thick and with a maximum span not exceeding 8 ft. These are carried between steel beams, which themselves are designed about as in the United States, although some of them carry heavier live floor loads than are customary here for purely office buildings. In many cases the girders between columns are made of heavy double channels, back to back, where these will carry the load adequately; I-beams of 18 and 20 in. depth, however, form the usual girders of these buildings. All three buildings have built up plate and angle columns of H-section and of unusual weight.

In stiffening the spandrels and their connection with the columns, the device adopted consisted of two diagonal members or knee braces above the spandrels and running at about 45 deg. from the quarter length of each spandrel to the adjacent column. These members themselves are then tied together by angles running horizontally just below the mullioned windows. This horizontal is again connected at its center point to the spandrel by two light channel diagonals reaching the spandrel at about the points of attachment of the knee braces. In each of these cases, the gusset plates are of sufficient area and weight to form a thoroughly rigid connection. In some cases a further tie is arranged by carrying vertical angles in the mullions from the horizontal already mentioned up between windows to the spandrel of the floor above.

Much of the terra cotta finish on these buildings may be expected to have shaken off as a result of the severe motion of the earthquake. In some cases, particularly with projecting cornices and other decorative elements, tie rods similar to concrete bars were passed through the terra cotta members and many pieces may thus have been held in place. Obviously, however, it was impossible to do this for all of the surface finish. Another device to hold the terra cotta in place consisted in making the spandrel of two angles and one channel back to back and separated by a small space, with washers on the rivets to maintain the space. The terra cotta was then fitted so that this space was available for an anchorage to hold it in place. The same arrangement, somewhat differing in detail, was made in some cases in connection with the horizontal angles passing immediately beneath the windows.

While some of the earthquake studies have shown a definite amplitude of movement of the earth's crust, it has not been the practice to design the buildings to meet any such pre-determined condition. The buildings were designed, however, on the assumption that they were to resist a certain intensity of movement, that is, a definite acceleration in any direction.

The Marunouchi Building measures 331 ft. by about 300 ft., and is eight stories high. Above the third floor there are two large courts running up through the remaining distance. The Nippon Yusen Kaisha Building measures 152 to 286 ft. The building of the Japan Oil Co., also of seven stories, is nearly square, being 153 by 159 ft.

Building Labor Inefficiency Bred by Booms

How Proper Training of Men Acts as Direct Stabilizer of Construction Costs Pointed Out in The Constructor

By LEONARD C. WASON
President, Aberthaw Construction Co., Boston

Observers who have watched and studied industrial activities covering a wide span of years often lapse into reflective moods and ponder upon the apparent passing of the efficiency of employes in days gone by. They compare present conditions with those that existed when lads became apprentices, learned their trades, worked at them conscientiously and with skill and thus provided the nation with their peak productive abilities. Such conditions stand in marked contrast

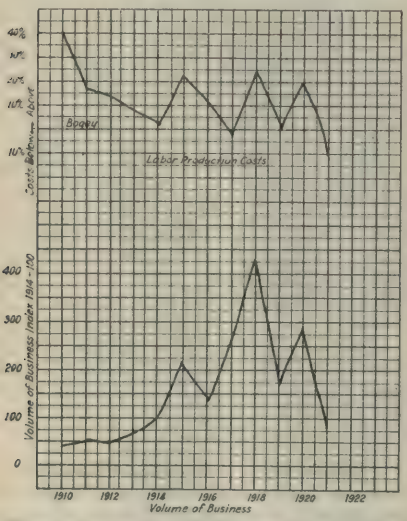


Chart showing how the training of employes results in ability to hold down costs durin periods of peak labor demand.

to those which industry now is forced to meet.

A general lack of intensive training of workmen has combined with presence of abnormal fluctuations of supply and demand to make the average workman of today far less conversant with the niceties of his trade than his predecessor of a few years or decades ago. Constantly moving from one job and supervision to another in his efforts to take advantage of temporary and abnormal conditions, he cuts down his efficiency. No matter how familiar he may be with the job in its generalities, this constant changing prevents him from becoming intimate with his fellow-workmen, with those who supervise his work and with the particular operating policies of his employer.

This factor of inefficiency, intangible as it may appear, is having a marked effect upon the general labor conditions of the country.

Trained Men 50 Per Cent More Valuable.—The value of men trained to their jobs has been held by some experts to reach as high as 50 per cent over that of employes who are not thoroughly familiar with the fine points of their work and the organization in which they are employed. While this estimate may be rather extreme, it is certain that a wide margin rests between these two values, varying as regards the nature of the work. The above is entirely independent of the artificial and arbitrary limtation of output that is practiced sometimes by labor organizations.

Studies of this phase of the labor problem are highly interesting, for they hold possibilities of developing a means whereby the demands for labor may be met without taking men from one job to another merely through the destructive process of raising wages higher and higher. In addition, it is obvious that an increasing of the efficiency of labor will have its effect in stabilizing industrial operations by holding down the unit costs of labor.

Industries having marked periodic booms, such as have characterized construction activities since the nation began making a distinct demand for industrial expansion, have the greatest reason for applying themselves closely to these studies.

The Alberthaw Co. has gained from its research and statistics in this connection a clear demonstration of the value of educating its employes to their jobs in the broader sense, and has gained inspiration for intensive work along this line from the results already achieved.

Dilution of the company's standing crews of workmen with outside help

in boom periods has resulted, according to its statistics, in a variation in output of from 25 to 35 per cent, with the figure mounting still higher in cases where common laborers are concerned. These conclusions are based upon the experiences and opinions of eleven Aberthaw superintendents who made close observation in 1915 of the effect exercised upon output by the hiring of men in local markets.

Boom Times Breed Inefficiency.—It is impossible to gather statistics covering the work of identical gangs of men in both boom and dull periods, due to the fact that jobs in the stretches of decreased activities are handled almost exclusively by Aberthaw men who follow the company from one job to another and seldom work for another concern. But the effect of bringing "outsiders" in on the jobs in stretches of greater activity may be taken as a fair gauge of the value of training.

The sawtooth appearance of the upper curve in the chart shows the effect of "good" and "poor" times over a period of 11 or 12 years. The horizontal line marked "bogey" is their standard, the word being borrowed from golf. If it is equalled, they think they are doing very well.

Comparison of the line of labor production costs in this chart with that of the volume of business indicates a decrease in efficiency in "good" times and a corresponding increase in less active periods.

The chart shows that the company was getting results 12 per cent better than its standard in 1921, which, in spite of the higher wages then paid, made the unit cost of production almost as low per unit in dollars as years ago when labor was much cheaper. This increased efficiency can be credited almost in its entirety to the fact that work in the duller periods was being done by Aberthaw men who "knew their jobs."

The marked inefficiency in the curve of 1910 was due largely to the fact that the company had not previously followed the policy of training men, but rather had followed the more usual method of taking them helter-skelter as the occasion required. The drop from 40 to approximately 15 per cent of inefficiency during the first year the training policy was in force demonstrated the value of the new plan. The labor production costs kept dropping as a result of this training of men, and continued the decline until the beginning of the war in 1914. Even in 1918, when the volume of construction mounted high, the balancing influence of this training held production costs from going more than a trifle above the 1915 mark, although the total amount of work had almost doubled in that time.

It is interesting to note that labor production costs actually were running opposite to the volume of business in 1912 and 1913, when the demand for labor naturally would have boosted wages so as to send labor costs in the same direction as the demand for labor.

It is plainly indicated that in dull times the costs of the various jobs were held close together, but that when boom conditions called for untrained labor, the costs went awry, with great variation being shown between the high and low levels.

Proper Training as Stabilizer.—Following out the thought inspired by this indication, the conclusion logically is that proper training of men engaged in construction work is a direct stabilizer of construction costs.

Any factor that acts to prevent a wide variance arising between costs of various construction jobs being carried on at the same time exercises the power of creating confidence and certainty in operations. By influence, it tends to increase the period of confidence and decrease the period of uncertainty. Automatically, since labor costs are more stable in periods of confidence, if such terms be applied, the entire movement is to stabilize the industry by action and reaction, with the forces of both action and reaction contributing to the result.

With continuing stabilization of the industry, peaks calling for the use of untrained men on jobs would be eliminated, so that training would be made more generally possible.

So the entire trend of the industry might swing around in a cycle as beneficial to its operations as the present "vicious cycle" of costs, prices and costs is detrimental.

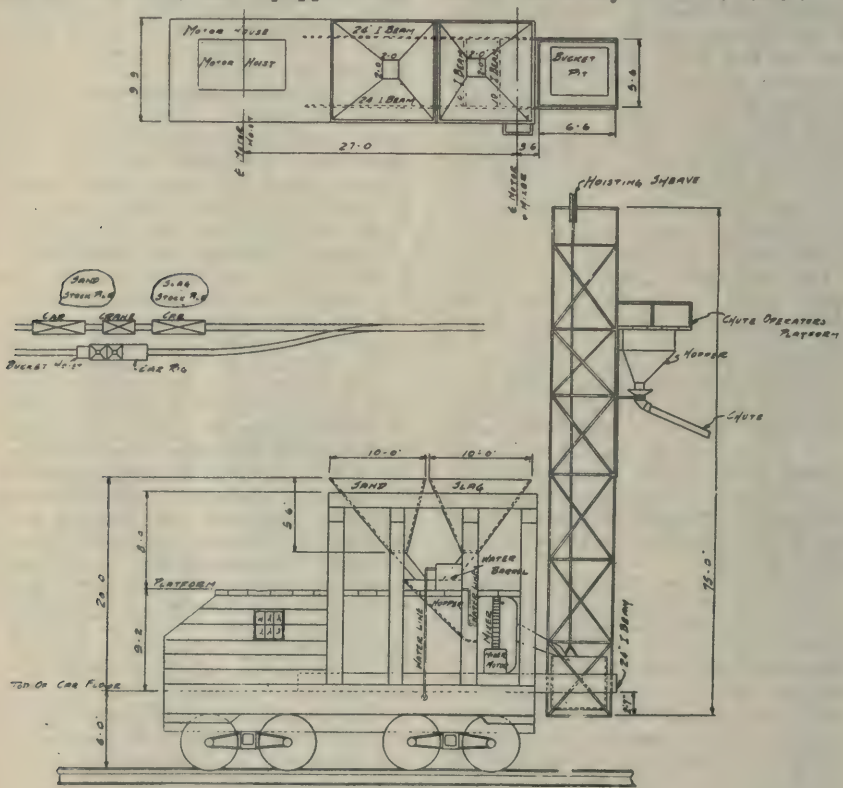
Bringing the subject down to specifics, the experience of the Aberthaw Co. seems to prove conclusively that costs may be controlled by an induced efficiency, which will perform remarkably well under fairly normal conditions and will exercise its influence against extreme costs even when the labor demand is at its height.

Movable Mixing, Elevating and Chuting Concreting Units

In connection with the large additions to its plant in Cleveland, O., the Otis Steel Co. devised a very practical layout for handling the 50,000 cu. yd. concrete end of the job. The arrangement is described in the August Successful Methods.

To meet the problem, three car plants were used, each equipped with a 1-yd. electrically driven mixer, electric hoist, 60-ft. steel tower and 100-ft. boom counterweight chuting plant. In rigging up the car plant, a standard gage steel frame car was used and two 24-in. "I" beams were attached to the frame of the car so that they extended out over one end approximately 7½ ft. The steel tower was then fastened to these "I" beams by means of gusset plates.

This method of supporting the tower not only gave more room on the car for the hoisting engines, bins and cement shed, but also kept down the over-all height of the car (which is a very important consideration with any type of car plant) because the bucket could be dropped down to practically ground level for loading. As soon as the plant was moved up into position where it was to pour concrete, the tower was immediately blocked up from the rails. Only one set of guys was used on the tower and the plant placed concrete over 100 ft. each way from the tower.



Arrangement of Movable Concreting Plant.

The method generally used for the operation of this plant was as follows: Two tracks were laid, one for the car plant and the other for the crane and cars of material. A car of slag was placed ahead of the crane and a car of sand behind it in such a position that the boom could be swung around and a bucket of sand or slag could be handled to the bin with the least amount of time lost. When the cars were emptied, the crane pulled them out and replaced them with loaded cars.

Wages and Average Employment in Building Trade

Some interesting information on the above subject was given by Gerhardt F. Meyne, building contractor, Chicago, in a letter to the editor of the Christian Science Monitor, commenting on an editorial in that paper. We reprint Mr. Meyne's letter below:

The writer of an editorial appearing in the Christian Science Monitor, dated Aug. 7 last, is evidently misinformed or misguided as to the earnings of the craftsmen of many of the common trades employed on buildings, making particular mention of the bricklayer, the plasterer and painter. He states that the bricklayer's wage is $1.50 an hour or $12.00 a day in New York and the plasterer also obtains $12.00 a day with an average employment of 170 days a year. He computes that the plasterer earns on an average of $8.00 a day. He, further, computes the painters' average $7.00 a day. The Monitor, further, compares the wages of 1912 and 1913 and brings out that living costs have increased, according to its calculations, 70 per cent to 80 per cent, and then concluding that $12.00 a day is found not far removed from the artificer of 1912 and 1913.

These following costs and facts have been taken from builders' time books, official wage scales of the various cities, and show the earnings of these craftsmen in 1912 and in 1913. A comparison will show a much wider spread in percentage than the Monitor's information:

New York builders paid bricklayers in August, 1912, 70 ct. per hour—in 1923 the pay is between $1.50 and $2.00, with $2.00 predominating.

Chicago builders paid bricklayers in August, 1912, 72½ ct. per hour—in 1923, $1.65 to $1.85 an hour.

Boston builders paid bricklayers in August, 1912, 60 ct. an hour—in 1923 up to $1.85 an hour.

New York builders paid plasterers in August, 1912, 68¾ ct, an hour—in 1923, $2.00 an hour.

Chicago builders paid plasterers in August, 1912, 75 ct. an hour—in 1923, $1.75 to $2.00 an hour.

Boston builders paid plasterers in August, 1912, 65 ct. an hour—in 1923, $2.00 an hour.

New York builders paid painters in August, 1912, 43¾ ct. an hour—in 1923, $1.25 an hour.

Chicago builders paid painters in August, 1912, 60 ct. an hour—in 1923, $1.25 an hour.

Boston builders paid painters in August, 1912, 41 ct. to 50 ct. an hour—in 1923, about $1.12½.

The Monitor is also misinformed as to the average number of working days these craftsmen are employed during the year. The average of bricklayers in the last years has been 257 days, which, at the going rate in New York, is about $4,000.00 per annum. The bricklayer demands for himself a half holiday on Saturday and thereby denies himself an earning capacity of an additional $400.00. He will confine himself to 8 hours' work between the hours of 8 a. m. and 4:30 p. m., and is unwilling to make up a rainy hour after 4:30 p. m. in order to complete his 8-hour day. The plasterer can average, if he is willing to work, 280 days a year, which, at the going rate in New York, will yield him about $4,500.00. He, also, refrains from working Saturday afternoon and deprives himself of $420.00, unless he can impose upon his employer or the owner of a building for overtime. In New York and Chicago and other sections of the country he insists that he must be employed 9 to 10 hours a day, Saturday afternoons and Sunday and exacts for this imposition double time for anything after 4:30 p. m. Saturday afternoon or Sunday, thereby increasing his earnings and income substantially. The Monitor's attention is directed to news items appearing in the New York Times of July 10, 13, Aug. 5, etc. They deal particularly with the bricklayer and plasterer situation. The painters' average employment time is about 250 days a year, although the skilled man is sought after and can work full time. The average painter in New York earns $2,500.00 per annum. He, also, deprives himself of earnings on Saturday afternoons.

When the Monitor speaks about the cost of living it must not forget that a large portion of the high cost of living is due to high rent, most of which is directly chargeable to labor

in general, the going building mechanics' wage and inefficiency that the craftsmen is imposing. If, according to the author of the editorial in the Christian Monitor, in 1912, $4.00 to $5.00 was the wage earning, or about $1,500.00 a year, and today he earns between $4.000.00 and $5,000.00. The Monitor's own ratio of increased living cost and the actual wage increase does not bear comparison and is therefore misleading. However, the wage increase is not the only item of concern. The loss of efficiency and production is where the real increase and imposition appears. In 1912 a 72½ ct. an hour bricklayer produced or laid in a wall from 2,000 to 2,500 brick per day on the average commercial type of building, making the labor cost about $2.25 per thousand. Today the bricklayer is producing somewhat less than 1,000, for figuring purposes we will call it 1,000, making the average cost of brick laid in New York City about $16.00 per thousand, an increase of about 700 per cent or in relation to the author's cost of living (70 per cent) the increase in production cost is 1000 per cent for mason labor. The plasterer's ratio is considerably higher and a little more difficult to illustrate, but the foregoing is sufficient to show that the Monitor's article needs guidance as to facts. The Monitor has referred to the New York Times news item of the 5th, which shows in detail how the plasterer is earning $119.00 per week in New York City.

The reason for the possibility of these impositions on the public is because of the fact that the building artisan is permitted to enjoy a monopoly obtained largely through intimidation, organization and in some instances legal license. The coal miners, of whom the Monitor speaks, enjoy such a legal license granted by some of the states, The Monitor refers to the few days of employment in a week that the coal miner may work and that he can hardly be blamed for exacting sufficient pay for his subsistence. Why should he look for other employment if in a few days he can make enough to live on? The coal miner apparently cannot be induced to seek other and more remunerative employment that would engage his full time. Why does he stay at mining when the country is clamoring for men to work?

Ten Years in Wood Preservation

A detailed report on the quantity of wood treated and preservatives used in the United States in 1922 and previously, prepared by the U. S. Forest Service in co-operation with the American Wood-Preservers' Association, will be included in the Nineteenth Annual Proceedings of the Association soon to be ready for distribution. A resume of this report, from Wood Preserving News, follows.

In 1913 the railroads utilized about 90 per cent of all the timber treated, and operated 40 per cent of the 93 plants. In 1922 they used about 80 per cent of the total output and operated about 22 per cent of the 128 plants. Since the railroads are using a greater quantity of treated timber than ever before, these figures show that there has been a substantial gain in the consumption of treated timber for other than railroad purposes.

The high record of production was reached in 1921 when 201,643,228 cu. ft. of timber were treated. A slight falling off occurred in 1922, directly traceable to the financial retrenchments of the railroads, the largest users of treated material, combined with the car shortage and coal strike that affected the operation of treating plants.

A comparison of the output of treated timber in 1913 with the period 1918 to 1922, inclusive, shows as consistently as possible the recovery that has been made since the world war.

For years cross-ties constituted over 75 per cent of all the timber treated in the United States. Approximately one-half of the annual tie requirements of the railroads are treated. Of the cross-ties treated in 1922 nearly 50 per cent were treated with creosote, 40 per cent with zinc chloride, and most of the remainder with a mixture of zinc chloride and croesote. The calculated average absorption of preservatives per cubic foot of the cross-ties treated in 1922 was: Creosote, 6.59 lbs.; zinc chloride, 0.5 lb.; zinc chloride and creosote, 0.5 lb. and 2.74 lbs., respectively. Over 15 per cent of the 41,316,474 cross-ties treated in 1922 were either adzed or bored, or both, before treatment.

In 1921 the output of creosoted piles touched the low mark during the past 10 years. In 1922 the volume jumped 25 per cent to 11,085,005 lin. ft. The average absorption of creosote was

MATERIAL TREATED IN UNITED STATES, 1913 AND 1918-1922

Kind	1913	1918	1919	1920	1921	1922
Cross-ties (No.)	40,260,416	30,609,209	37,567,927	44,987,532	55,383,515	41,316,474
Piles (Lineal ft.)	11,766,852	12,286,518	13,557,519	11,965,912	8,268,519	11,085,005
Poles (No.)	142,069	262,260	378,481	585,781	622,685	966,400
Wood blocks (Sq. Yd.)	2,611,821	2,398,969	1,795,683	2,568,171	2,363,011	1,503,879
Cross-arms (No.)	2,944,045	683,077	121,507	514,209	175,403	604,758
Const. Timbers (Bd. ft.)	138,843,536	122,587,116	144,742,476	139,749,732	142,520,496	152,556,960
Misc. Lumber (Bd. ft.)	24,475,896	11,086,356	8,113,632	14,864,268	9,037,212	13,560,432
All Mat'l, Total (Cu. ft.)	153,613,888	122,612,890	146,060,994	173,309,505	201,643,228	166,620,347
Plants in Operation	93	107	108	115	122	128

13.3 lbs. per cubic foot. In recent years a few piles were treated with zinc chloride, the average absorption being 0.5 lb. per cubic foot. The species treated, in order of volume, were southern pine, Douglas fir, cypress and cedar.

In 1922 a total of 966,400 poles were treated, the largest number ever reported. Comparing the number treated in 1922, when 37.5 per cent of the poles were pressure treated, with 1920 when the ratio was 28 per cent, there is shown increase of 122 per cent. Cedar and chestnut butt treated poles in the same period increased 46 per cent. The pressure treated poles received an average of 9.4 lbs. of creosote per cubic foot.

Unusual building depression in 1922 had the effect of greatly curtailing the demand for creosoted flooring and paving blocks, resulting in an annual output of 1,503,879 sq. yds., the smallest quantity since 1909. Sixty-five per cent of the 1922 output was for flooring and the balance for street paving. Southern pine was the principal wood used. The paving blocks were treated with an average of 12.53 lbs., and the flooring with 7.89 lbs. of creosote or paving oil per cubic foot of timber.

The output of creosoted cross-arms in 1922, amounting to 604,758, was the largest since 1918. They were treated with an average of 8.92 lbs. of creosote per cubic foot.

Construction timbers include all timbers for highway and railway bridges, docks, wharves, public works, switch ties and similar heavy structural material. In all 152,556,960 board feet of construction timbers were treated in 1922. Nearly 85 per cent of this timber was treated with creosote, averaging 10.07 lbs. per cubic foot; about 10 per cent with zinc chloride, averaging 0.5 lb.; and the remainder principally with a mixture averaging 0.428 lb. zinc chloride and 2.83 lbs. creosote per cubic foot.

The miscellaneous lumber treated in 1922 aggregated 13,560,432 board feet, the largest output in three years. Most of this material was treated with creosote, the average absorption being 10.36 lbs. per cubic foot; some with 0.495 lb. of zinc chloride, and some with a mixture of 0.506 lb. of zinc chloride and 2.97 lbs. of creosote.

The Strength of Sheet Glass

For some time the U. S. Bureau of Standards has been investigating the breaking strength of sheet glass. The results obtained by breaking sheet glass in frames have been computed, and a comparison of these data shows, in the case of the uniform hydraulic loading of glass over its entire area, that the thickness has considerable effect upon the strength obtained. Thin glass gives a strength which is quite high in proportion to its thickness. This strength decreases rapidly with decrease in thickness, determinations having been made for glass from 1/10 to 1/4 in. thick. Glass, when tested in frames and loaded in the center, shows a strength almost comparable with that which it would exhibit if acting as a beam supported on two ends only. The results above described have been obtained using a single size of sheet, and the tests will now be repeated on sheets of various sizes to determine if this has any effect on the values obtained.

Invar and Related Steels

Circular 58 of the U. S. Bureau of Standards on Invar and Related Steels, has recently been revised, and the second edition can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 30 cts. a copy.

This circular is mainly a compilation of data obtained during the last 30 years by various investigators on the different properties of nickel steels. Particular attention is given to "invar," a nickel-iron alloy containing about 36 per cent nickel and possessing an extremely small thermal expansivity between 0 and 46 deg. C. being of the order of 1 to 2 millionths. The results of investigations made on the various properties

of the nickel-iron alloy series have been presented largely in diagrammatic and tabular form.

Following an historical account of the development of nickel steel and studies of their properties, the nature of the anomalies in behavior met with in these steels and characterized by their irreversible and reversible phenomena are discussed in the light of results obtained on their various physical properties. The constitution and microstructure of these alloys are first dealt with, and next the rather extensive studies made on the magnetic properties. A magnetic transformation (Curie points) diagram has been plotted from the observations obtained magnetically, for the most part, by various investigators.

Trade School Development

Thought is congealing in connection with the trade schools movement throughout the United States.

According to a News Letter of the Associated General Contractors, preparations made by various organizations, school boards and other unified centers of thought are indicating a response in creative progress to the demand being made for assurance of a substantial supply of skilled labor for the building trades. One indication of the general progress being made in this direction is found in the activity of the Common Brick Manufacturers' Association of America. Announcement has been made that a textbook covering essentials of the training of bricklayers practically is ready for distribution at a nominal price as a part of the program necessitated by economic conditions.

It is proposed that a national director be named to introduce schools where needed. Different communities, under this plan, are to receive his services on a per diem charge. The local employing and material associations will, in this manner, contribute towards his support, which will aid materially the starting of a school in their section. Under such a plan as this, a director will be practically self-supporting.

With proper endorsement, it is believed by the proponents that many organizations can be induced to lend their support.

Standardized Elementary School Buildings

A plan is being worked out for the standardization of small grade schools of Boston, Mass., so that hereafter they will be constructed on a definite model which will allow for logical expansion of the building to meet the requirements of the population of the district. However, the building will be so designed that an unfinished looking exterior will not appear.

The initial building, the first one to be erected in the near future in Germantown, contains three classrooms, a nurses' room and a kindergarten on the first floor. The kindergarten is so arranged that it is available for the purposes of a small community hall after regular school hours are over. The basement of the initial building will have full provision for all heating and plumbing necessary for the completed building and also a playroom for girls, to be used in foul weather. When the first unit is built the second floor will be constructed complete with the exception of the top flooring. Over this will be a temporary roof. The exterior walls will be run to the sill line of the future second-story windows.

The building will be expanded in units of four classrooms, with the necessary service. The first addition will be a second story containing four classrooms and a teachers' room over the first building already described.

The plan is so designed that it is symmetrical about an axis taken through the center of the corridor. For the second addition, the first plan is folded over so that an additional four classrooms and a master's office are constructed over a new basement which contains a boys' playroom and additional space for lunchrooms, shops and storage.

The final unit of four rooms, making the building a 16-room school with all the necessary service, is constructed in a second story over the second addition. This last addition contains four classrooms and an emergency room.

The exterior will be brick with limestone sills, cornices, entrance, etc., over a granite base course.

The classrooms will conform to the existing standards of the Boston schools.

The architect of the work is William W. Drummey, 80 Boylston St., Boston.

Roads and Streets

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.
221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*
LEWIS S. LOUKE, *Vice-President and General Manager*
New York Office: 904 Longacre Bldg., 42d St. and Broadway
RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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Vol. LX. CHICAGO, ILL., OCTOBER 3, 1923 No. 4

"Our Reckless Driving"

The increasing necessity for greater road safety is emphasized in the following letter which we received in reply to an editorial in our last month's issue.

While we have seen other references to Judge Olson's address we have not yet had opportunity to read it, and in the absence of certain specific information we are not inclined to express a definite opinion of the extent to which tests might be practical for the purpose set. Undoubtedly some of our readers will look upon most mental tests as unreliable and emotional tests as wholly impractical. The reliability of physical tests, on the other hand is subject to little question. The difficulty with the latter as a protection against unfit drivers is that faulty brain work rather than physical defect is responsible for the vast majority of accidents.

The editor is frankly skeptical of any test system as a complete safeguard against bad driving, but that is not an argument that it is worthless. Similarly we still think that punishment, though not a panacea, is a valuable aid to safety, and as evidence we cite the improvement in Chicago following inauguration of the drive against recklessness. Also, who has not at some time heard a driver say while crossing certain towns, "Well, I must be careful here: the speed cops are sure vicious"?

While we did not emphasize the revocation of license in our last month's issue, we have advocated it at other times—among them in our March 7, 1923, issue as follows:

"The fine may properly be retained for many offenses, but for sheer recklessness the driver's license should be revoked. We believe that nothing would bring a change of habit to so many reckless drivers as a knowledge that their offense is reasonably sure to lead to their deprivation of the right to drive."

Our correspondent's letter follows:

To the Editor: Your comments on auto criminals and heedless driving in

the Sept. 5th issue have caught my eye.

In my opinion not enough attention is being given to current discussion of this matter, to the limiting of the privilege to drive to those with the necessary physical, mental and emotional qualifications which go to make up a safe and sane driver. The railroads require their engine drivers to demonstrate that they have certain physical requirements, besides subjecting them to careful observation of their dependability for the proper performance of the particular duties with which they are entrusted. But anyone with enough guts has the right, apparently, to pilot a car on our streets, where the lives of thousands of fellow drivers and of pedestrians may be jeopardized. The driver does not have to pass tests to prove that he has the requisite good eyesight and other inherent qualities that go to make up a responsible and safe driver. No amount of propaganda directed along lines of education of drivers to greater caution, can reach the element that is inherently unfitted to drive. Doubtless many of these dangerous drivers are good citizens in most other respects and may not appreciate their unfitness to exercise the privilege of piloting a car on a public thoroughfare. But there is also probably a goodly share of criminals among the reckless drivers. The test is the way to eliminate them all.

If you are not already familiar with it you might be interested in Judge Harry Olson's recent address on "Crime and Heredity," which I think has a bearing on the question of auto driving. You can obtain a copy of the address I mention by applying to the clerk of the judge's court in the City Hall, for the August issue of the Journal of the American Judicature Society. The judge brings out clearly the fact that antisocial traits and proclivities are inherent in the individual. The principle certainly applies to auto driving.

The problem is to find those inherently unfitted to drive—those not safe to trust with a car, and to find them before the accidents. A good place to begin might be to examine those who have caused accidents—but eventually license to drive should be limited to those who have qualified in suitable, physical tests and in mental and emotional tests such as those Dr. Hickson uses, (adapted to auto drivers), with severe penalty for unauthorized driving.

I have perhaps been rather lengthy, but I am convinced that if we are to get to the bottom of this matter it must be along the lines I mention. If you will read carefully the address I refer you to, and then consider in connection with that the eyesight and other tests which railroads use in passing on the fitness of locomative engineers, I think you will appreciate what I have in mind.

DONALD H. MAXWELL.

Wilmette, Ill.

P. S. I have just glanced back at the title to your editorial which reads, "Education and Punishment for Reckless Drivers." Read Judge Olson and you will get a new light on that title. I think I am right in saying that in a sense you can't educate the really reckless driver and to punish him is futile. The cure is not to let him drive. D. H. M.

Causes of Automobile Accidents on Highways

Some interesting information on automobile accidents on Wisconsin highways is The Highway Magazine by N. M. Isabella, assistant maintenance engineer, Wisconsin Highway Commission. The commission started in May, 1922, to investigate the number and causes of automobile accidents on the state trunk highways, which comprise 7,500 miles or about 10 per cent of the total rural mileage in the state. The following table from Mr. Isabella's article shows the total number of accidents during the year 1922, and their causes:

Total number of accidents	1,069
Number of people involved	3,562
Number of people killed	94
Number of people seriously injured	312
Number of people slightly injured	935
Accidents occurring on straight road	718
Accidents occurring at curves or corners	185
Accidents occurring at R. R. crossings	66
Accidents occurring at cross roads	62
Accidents occurring at miscellaneous places	38
Accidents due to reckless driving	631
Accidents due to improper lights	61
Accidents due to broken car mechanism	45
Accidents due to intoxicated drivers	40
Accidents due to weather conditions	46
Accidents due to cars on wrong side road	17
Accidents due to miscellaneous causes	220

The above covers the time from May 1, 1922, to Jan. 1, 1923.

The above reports cover only the State Trunk Highway System outside of cities having a population of 2,500 or more. The majority of the reports were furnished by the patrolmen, supplemented by reports from newspapers and other sources.

The 1924 Convention and Road Show of American Road Builders' Association

Plans for the annual convention and road show of the American Road Builders' Association in Chicago, Jan. 14 to 19, 1924, are practically complete.

C. M. Upham, manager of both events, has worked out with the board of directors of the Highway Industries Exhibitors' Association arrangements for the show which are satisfactory to all concerned. The two associations are working together in complete harmony, practically as a single organization, to the one end of making the coming convention and road show the best that have ever been held. The important differences which existed at one time between the two associations have been entirely removed. Solutions have been found for the minor problems which caused some criticism last year. Many improvements in the plans for both the convention and the road show have been made. The one problem which apparently cannot be solved this year is the lack of space to meet the demands of those who desire to exhibit.

The road show will be held in the Coliseum, the Coliseum Annex and the Greer Building, the same as last year. It already is known that demands for exhibit space will greatly exceed the space available. This means that it will be impossible to give all exhibitors exactly the amount of space and the location desired. This program will be solved in the best way possible. One thing that will be insured is that each exhibitor will have to trim his display down to his very latest products only. These and various other developments are certain to make the 1924 show in every way the most successful industrial machinery exhibition ever held.

Mr. Upham has announced that applications for space have been mailed to all previous exhibitors and to a list of others who might be interested. Blanks also will be furnished to all who make application for them to the American Road Builders' Association, 37 West 39th Street, New York City.

Application blanks must be filled out and filed at the above address on or before Oct. 27. The allotment of space will be made the following week at Chicago by members of the executive committees of the American Road Builders' Association and the Highway Industries Exhibitors' Association.

One requirement of all applicants is that they be a member of the Highway Industries Exhibitors' Association and a contributing member of the American Road Builders' Association. This joint membership may be arranged by prospective exhibitors who are not members through S. F. Beatty, president of the Highway Industries Exhibitors' Association, 400 North Michigan Blvd., Chicago, Ill.

The program for the convention provides for much more attention to methods of handling construction and maintenance work, and to relations between the contractor, the engineer and the machinery and material producers than has heretofore been customary. These features of the program are still in process of development. Announcement of the details of them is expected to be made shortly.

Highway Safety Essay Contest

Renewal of its annual safety contests, in which $6,500 will be given away in prizes, has been announced by the Highway Education Board. The third annual safety campaign takes the form of two contests, one among elementary school pupils, and another among elementary school teachers. Approximately 500 state and national prizes are to be given for the best essays and lessons written on highway safety habits and training children in habits of safety on the highways. The prizes offered are the gifts of the National Automobile Chamber of Commerce, which is desirous of reducing the number of accidents and fatalities due to traffic mishaps. In the teachers' contest the first national award is $500 and a trip to Washington with all expenses paid. The second national award is $300, while the third award is $200. The first national prize for the best essay by pupils is a gold watch and a trip to Washington with all expenses paid. The second and third prizes are each gold watches, one of slightly greater value than the other. Four hundred and seventy-eight state prizes are offered pupils. Complete details will be furnished upon application to the Highway Educationa Board, Willard Bldg., Washington, D. C.

Motor Vehicle Production in August

The U. S. Department of Commerce announces August production of automobiles, based on figures received from 181 manufacturers, 94 making passenger cars and 115 making trucks (28 making both passenger cars and trucks). Data for earlier months include 10 additional manufacturers now out of business. Figures on truck production also include five apparatus and street sweepers.

Automobile Production (Number of Machines)

	Passenger Cars	Trucks
January	*223,708	*19,533
February	*254,651	*21,961
March	*319,637	*34,905
April	*344,475	*37,718
May	*350,181	*43,228
June	*337,144	*40,819
July	*297,257	*30,359
August	304,010	30,251

*Revised.

Trend of Retail Prices

Bulletin No. 334, recently issued by the United States Bureau of Labor Statistics, gives figures showing the trend in retail prices in 1922 for 51 of the principal cities in the United States for all articles for which retail prices are secured. As the year 1913 is the base for the computation of all relative figures and index numbers, average prices for that year are also shown for each city.

For the United States prices are shown by years as early as 1890. The trend in the cost of all articles of food, combined, shows a decrease of 8 per cent for the year 1922, as compared with the cost in 1921. The retail cost of coal in December, 1922, as compared with December, 1921, shows an increase of 3 per cent for Pennsylvania anthracite and 9 per cent for bituminous. The retail prices of dry goods for 1922 show that most of the 10 articles for which prices are secured were highest in December. Prices of electricity for household use are shown for specified months from December, 1914, to December, 1922, for 19 cities and from December, 1917, to December, 1922, for 13 cities. The price of gas for domestic consumption in December, 1922, was 34 per cent higher than in April, 1913, and 4 per cent lower than the peak price of May, 1921.

Retail prices are obtained directly from merchants and represent actual selling prices. The index numbers for the United States and for the individual cities for all articles of food combined are determined by weighting the average price for each article by the amount used by the average family. An explanation in detail of the scope of study and the method of obtaining prices and computing the index numbers is shown in this bulletin.

Road and Street Contracts Awarded During the Last 44 Months

The accompanying table shows three outstanding facts: First, that highway contracts awarded during the last half of each year have averaged only 25 per cent less in volume than those awarded during the first half; second, that there is not a month in the year without a very large volume of road and street contracts awarded; third, that each year shows a substantial gain over its predecessor.

ROAD AND STREET CONTRACTS EXCEEDING $25,000 IN SIZE

	1920	1921	1922	1923
January	$ 12,204,000	$ 11,598,000	$ 14,424,000	$ 21,691,000
February	21,334,000	12,049,000	9,052,000	18,781,000
March	26,221,000	25,880,000	39,669,000	37,706,000
April	33,340,000	31,026,000	32,991,000	29,641,000
May	30,258,000	35,064,000	42,284,000	46,528,000
June	31,441,000	56,777,000	42,138,000	38,040,000
July	29,353,000	33,943,000	26,087,000	42,397,000
August	18,565,000	28,693,000	37,035,000	35,639,000
September	26,537,000	23,257,000	28,884,000	.....
October	12,894,000	20,055,000	23,162,000	.....
November	12,443,000	20,751,000	20,892,000	.....
December	10,834,000	16,263,000	18,096,000	.....
Total	$265,424,000	$315,356,000	$334,714,000	.....

Note.—About 100 per cent must be added to these totals to give the grand total of highway contracts in the United States.

Bridges are not included, and bridge contracts average 15 per cent as much in value as road and street contracts. A great deal of road and street work is done by directly hired labor and is not included above.

Uses of Asphalt in Highway Construction

election of Type of Surface and Features of Design, Construction and Maintenance Described in Paper Presented June 11 at Annual Convention of Canadian Good Roads Association

By I. W. PATTERSON
Chief Engineer, Rhode Island State Board of Public Roads

Comprehensive treatment in reasonble space of the subject of asphalt urfaces is made rather difficult beause of the wide diversity of uses of sphalt in highway construction. A iscussion of asphalt surfaces of ourse cannot be confined to a single ype of pavement. Perhaps there is o material employed in highway contruction which has a wider range f adaptability than has asphalt. Asphaltic products are equally servtain features influencing the selection of the numerous separate types of asphalt surfaces, to discuss the design of highways constructed with asphalt surfaces and to touch upon certain practical features incident to the construction and maintenance of asphalt surfaces. The aim of this paper is service and the writer is of the opinion that maximum service can be rendered by treatment of the subject along the lines indicated.

vidence of Heavy Retentive Soil on New Location Calling for Insulating Layer to Interrupt Capillarity.

eable for surface treatment of cheap urfaces and for the construction of uch high types of pavement as biminous concrete and sheet asphalt.

The aim of this paper is not to deal holly with the technic of construcon and maintenance of asphalt surces, since it is the writer's belief at such a treatment in reasonable ace of necessity either would be ther superficial or largely eleentary. The technic of the uses of sphalt furthermore is treated very tensively today by the technical ess and by numerous reference oks, so manifestly simply a resumé the vast amount of written matter on the subject. The writer will enavor to dwell particularly upon cer-

Rhode Island Practice Described.—It is probably an axiom that any professional man in treating a subject having to do with his profession unconsciously colors his remarks to conform to opinions and theories which he gains in his individual practice. Perhaps therefore it would be advisable for the speaker to describe briefly the problem of state highway construction in Rhode Island. Although Rhode Island is the smallest state in the United States, it is the most densely populated. The dense population of course is reflected in highway travel. There are 50 per cent more motor vehicles per mile of rural road owned in Rhode Island than in any other state in the United States,

and it is reasonable to suppose therefore that the travel upon the state highways of Rhode Island averages heavier than the traffic upon any other state system of highways in the United States.

Rhode Island primarily is an industrial community. The use of highways in connection with our industries is very important. Heavy motor trucking upon our main highways has been in existence for many years. Rhode Island also is famed for its shore resorts, so that our highways are subjected to heavy tourist traffic in the summer season. The use of our highways in connection with our industries tends to stabilize our traffic so that there is not as great a difference between the traffic over our highways in the summer and the traffic in the winter as is the case in some northern states. Clearing of all our state roads from snow is considered to be a necessary service in view of the importance of highway transportation during the winter months. Motor trucking over our highways is fairly uniform in amount during the twelve months of the year.

Rhode Island was one of the first states in the United States to undertake the construction of state roads. Our system of main trunk lines was completed in 1912 and it was inevitable therefore that many of our roads built in the period from 1896 to 1912 were not designed according to modern standards. Some of the opinions set forth later in this paper frankly therefore may be attributed to observation of many failures due to faulty methods in our earlier practice. Surely much may be gained by studying failures as well as successes.

The initial adoption of bituminous surfaces upon the state highway system of Rhode Island was in 1906, and the use of bitumens in state highway construction and maintenance has continued since that time without interruption.

Foundations and Drainage for Asphalt Surfaces.—In view of the fact that asphalt surfaces are plastic rather than rigid, proper foundations and proper drainage of highways laid with asphalt surfaces are features of prime importance. Perhaps therefore the writer may be pardoned for devoting some space to this very important feature incident to the construction and maintenance of asphalt surfaces. It appears to be logical to consider separately two classes of asphalt surfaces in connection with a discussion of foundations and drainage. We have first the non-monolithic construction and we have second monolithic construction.

In the construction of non-monolithic types it is very apparent that the strength of the pavement is no greater than the strength of the base upon which the pavement rests. Prejudice against non-monolithic types of asphalt pavements in a great many instances may be attributed to failure due to foundation defects rather than to failure due to inherent weakness in the surface. The writer suggests that success in treating the subgrades of non-monolithic asphalt pavements to the end that stability will be secured at all seasons of the year is a factor contributing to success of non-monolithic types of asphalt pavements under traffic which in many places is considered to call for monolithic construction only.

In the northern portion of our continent the design of foundations for all types of pavement surfaces must be studied with a view toward protecting the surfaces against destruction by frost action. It is a matter of common knowledge, of course, that the season of the year which is accompanied by the greatest damage to our highways is the season during which the frost comes out of the ground. Manifestly, therefore, it is not sufficient for us to design our roads for conditions which exist in the summer only. It is necessary for us to anticipate the worst conditions, and those conditions prevail at the time of the year referred to.

A great deal of scientific study and a large amount of money is being spent now to eliminate some of the many indeterminates which the highway engineer meets in design of foundations and drainage facilities. These studies yet have not progressed to the stage where an analysis of subsoil may be made and a safe design carried out with mathematical precision in light of the results of that analysis. It has been found, however, that if capillarity in the subsoil under the pavement is eliminated, success is fairly certain to follow.

Capillarity in Subsoil.—In constructing non-monolithic asphalt pavements, we will do well to study carefully the subject of capillarity in the subsoil. The fact that the surfaces may be

waterproof is of little avail in keeping water out of subsoils of high capillarity, because the phenomenon of capillarity results in drawing the water from the side ditches and shoulders under the pavement. The fact that the pavement is waterproof appears to be more effective in preventing evaporation of water introduced to the subgrade by capillarity than it does in preventing saturation of the subgrade.

The interruption of capillarity in the subgrade is an elementary problem. Since the degree of capillarity is in inverse ratio to the sizes of interstices in the soil, it is apparent that the introduction of a layer of material of low capillarity directly below the pavement will eliminate many of the ills which non-monolithic pavements are subject to when laid over soils of high capillarity. In practice it has been proven that the theory is correct.

Insulation for Interrupting Capillarity.—Materials which may be introduced below the pavement to interrupt capillarity may be coarse or sandy gravel or field and wall stone. A wide range of materials are known generically as gravels. In specifying gravel for an insulating layer of the material by indicating a maximum limit in the percentage of fine particles. It is our practice to specify that of the material passing a 2-mesh screen not over 25 per cent shall pass a 40-mesh screen. A material furnished to comply with this specification we have found to be very effective in eliminating the disastrous effects upon non-monolithic pavements resulting directly from the action of frost upon fine-grained soils of high capillarity.

In some cases we believe that stone is very much more effective than is bankrun gravel. Upon many of our rocky hillsides, where the problem of foundations and drainage is complicated by the existence of pockets of soils of high capillarity together with decided flow of water in the fissures of ledges, we favor the use of a stone fill, so-called. The stone fill apparently is capable of taking care of a considerable amount of seepage which cannot be interrupted before it gets into the substructure of the road. Where the subsoil is particularly unstable, we favor a layer of gravel meeting our gravel specifications under the stone fill in order to prevent the unstable soil from working up into the interstices of the stone foundations.

Typical "Boney" Excavation. Material for Foundation Is Secured From This Excavation Without Haul.

Effect of Frost Action.—The depths to which gravel and stone foundations should be laid to insure the pavement against damage by frost action should vary to meet varying conditons of the subsoil. Unfortunately, we know of no definite rule to follow in the solution of these problems, and in consequence our practice is reduced to certain empirical rules which have been found by experience to be safe.

The foregoing remarks in regard to foundations and drainage are intended

to concern especially non-monolithic pavements, because all pavements of that type have little or no inherent strength. The most careful attention to the many details of construction of the pavement proper therefore is without avail unless the pavement is protected from damage due to trouble below the pavement proper. What has been said concerning foundations and drainage of non-monolithic types applies to the monolithic types, with the difference that monolithic pavements have inherent strength which ordinarily permits of considerable reduction in the cost of stabilizing the subgrade. There is little accurate knowledge available in regard to the character and degree of stresses introduced to pavements by reason of frost action. We know from experience that monolithic pavements may be seriously injured or even destroyed by frost action, so that it appears to be hardly safe practice to depend solely upon inherent strength of any pavement to insure success over particularly unstable subsoils. It is necessary of course to consider character and amount of traffic in this connection. Over subsoils which are particularly unstable it is believed that it is excellent practice to insert a layer of very permeable material below the pavement to interrupt capillarity.

Diagnosing Subsoil Conditions.—The problem of diagnosing subsoil conditions accurately is particularly difficult. Serious trouble may be experienced in sections where ledges are numerous, not by faults inherent to the subsoil, but by bars of ledge which interrupt the natural seepage with the grades and which thereby cause "frost boils" in the spring. It is our practice to carry out an intensive study of our subsoil conditions during the winter, and also during the early spring when the frost is coming out of the ground. Observation of conditions existing in the periods during which these studies are made is very valuable for use in the design of drainage and foundations. Manifestly there is much more to be gained by examination when conditions are at their worst than there is by examination when conditions are at their best.

The particular treatment of the subgrade described previously may be considered to contemplate the securing of substantial foundations and of effective drainage in one operation. It is treatment of that sort which we have found to be more effective in many cases than drainage only. We have certain subsoils which we find cannot be drained satisfactorily, and it is these soils which respond readily to the treatment as outlined.

Our intensive study of subsoils previous to making the design has led us to abandon completely standard designs below the pavement proper. We attempt first to locate each weak spot, then to study the reason for each weakness and finally to adopt a method of treatment for each separate case which is aimed to eliminate the weakness. Unless subsoil conditions are uniform, a uniform design either invites disaster in the worst places or involves a needless expense resulting from construction unnecessarily heavy where conditions are more favorable.

It is believed that the study of foundations and drainage of pavements laid upon typical city streets which are curbed and which have paved sidewalks is a vastly different problem from the design of similar types of pavements in rural sections where the shoulders immediately adjacent to the road necessarily are subject to saturation.

Selecting Type of Surface.—There is so great a diversity in the types of asphalt surfaces that the problems of selecting for a specific project the particular type of pavement to be used is not simple. Some of the features whic hit is necessary to consider are the costs, the possibility of employing as a base the existing road, the availability of materials and the traffic requirements.

In selecting for a given project an asphalt pavement to meet the requirements of the purse, it is decidedly impracticable to determine upon one of the higher types of asphalt pavement unless there is sufficient money available for the project to permit of following the best standard practice in design, selection of materials and construction methods. It appears to be true without question that inferior service rendered by asphalt surfaces in some cases may be attributed directly to deliberate cheapening necessitated in order to conform to the requirements of the purse. In the construction of asphalt pavements, as in the construction of all other types of pavements, the fundamental features governing the design of pave-

ment to insure durability are of the utmost importance.

It is a temptation to many engineers to select for projects very high types of asphalt pavements rather than the cheaper types. The expenditure for the higher types of pavements necessarily is high, even though there be an attempt to reduce the initial cost at the expense of service rendered by the pavement. The failure of a pavement as expensive as the higher types of asphalt pavements, due to neglect to build substantial value into the pavement, is an economic waste. Unless the higher types of pavements can be built as they should be, it is believed that substantial surfaces of lesser cost are preferable.

As an example, the selection of an asphalt macadam pavement under conditions which compel the selection of inferior materials and the adoption of a weak design in order to make the cost of the project meet the requirements of a restricted purse is a mistake. Economically a better course to follow without doubt would be to select a gravel or a light macadam wearing surface laid upon foundations which are as near permanent as they can be made. Investment for the cheaper surface substantially designed and properly built in a great many cases will prove to be the better course to follow. Destruction of the more expensive asphalt macadam surface within a very few years by reason of foundation defects rather than by reason of defects inherent to the pavement itself involves of course a serious loss.

In the same way asphalt macadam perhaps may be found to be a more satisfactory selection than one of the higher types of asphalt pavements, provided there is not money enough to build one of the higher types of pavement as it should be built.

Old Gravel or Macadam Road as Bases.—Since asphalt surfaces vary from the inexpensive surface treatment of gravel roads or macadam roads to the expensive and durable bituminous concrete and sheet asphalt surfaces, the selection of asphalt types frequently permits of taking full advantage of existing roads. An old macadam road which is extremely rough but which is not subject to serious foundation defects provides an admirable base for an asphalt surface subjected to moderate traffic. In attempting to make existing roads serve as bases for asphalt surfaces a very careful study of the existing roads is essential. Whether the treatment be confined to protection of the surface of the existing road only by means of spraying bitumen over its surface or whether one of the many types of asphalt pavement be selected, it is not policy to permit weak spots to remain without attention in the existing road. Manifestly of course the more expensive the type of asphalt surface selected, the more important it is from the standpoint of economy to insure stability in the existing road which is to serve as a base.

There are few communities today in

"Insulating" Layer of Sandy Gravel Over Soil of High Capillarity.

which the public demand for good roads may adequately be met, because of the impossibility of providing sufficient funds. Upon many very heavily traveled thoroughfares it may be impracticable to attempt to capitalize fully in connection with betterments the values of the existing plain macadam or gravel roads. Upon routes of secondary importance, however, many times improvement is impossible unless advantage is taken of substantial existing roads. A substantial macadam road especially, regardless of how rough it may have become under traffic, supplies for modern traffic an excellent base for several types of asphalt surfaces. Taking full advantage of the old roads so that the original investment is not completely thrown away is commendable in many cases where the travel is not too heavy.

If an attempt be made to realize an appreciable value from existing roads, we must study the matter of selection of types fully as intensively as though the improvement contemplates complete reconstruction with no attempt to take advantage of the existing road surface. Ordinarily it is not policy, for instance, simply to scarify the old macadam surface and to harrow it and then to apply bitumen to the old road metal with an attempt to secure an asphalt macadam surface. Rather than to experience the poor results ordinarily following that method, probably it would be better practice simply to scarify the existing surface and to apply a surface treatment.

Taking full advantage of old macadam roads in the construction of new surfaces is not a simple task. In a great many cases, however, it is perfectly possible and is very commendable upon economic grounds.

Points to Be Considered in Selecting Type of Surface.—In selecting an asphalt surface for a given project it is essential of course to study the matter of availability of materials suitable for the verious types of asphalt surfaces. The farther the site of the project is removed from railway or from waterway transportation facilities, the more important it is to study the adaptability of the local materials. For a project far removed from railroads and not possible of being served by water transportation, surely it would be short-sighted to elect an asphaltic macadam pavement, provided the only stone available is not suitable for that type of construction and provided there is available locally a supply of material excellent for use in bituminous concrete construction. The reverse is equally true. An exhaustive study of supplies of road building materials always is absolutely necessary if economy is to result.

Correlating the character of the improvement to the traffic to which the road will be subjected of course is a necessity. No one seriously expects to secure sheet asphalt service by surface treated gravel. In the same way it is illogical and impracticable to supply a sheet asphalt pavement for a surface treated gravel demand. If we are to consider our investments for public highways in the same light that we consider investments of private capital in other industries, we must adopt some logical plan of computing comparative values of different types of pavements under various types and volumes of traffic. Perhaps it is logical in comparing economy of service rendered by various pavements to compute for each the ultimate annual cost, which is made up of three components, viz., the interest on the initial investment, the annual maintenance cost and the resurfacing cost computed upon an annual basis. If this study is carried out, it will be found in some cases that the interest on the investment for a very expensive type of pavement is a great deal more than the probable maintenance cost of one of the cheaper types of pavement. If satisfactory service to traffic can be rendered by a cheaper type, therefore, it is doubtful if a more expensive type in that particular instance would be economy in the long run. We cannot always expect to build roads which will be entirely free from repair for many years following their construction.

All of those actively engaged in highway work, especially if they serve the public directly, perceive the absolute necessity for considering expediency in planning their work. It is believed that no commission in control of highway improvement absolutely can eliminate the element of expediency in making decisions. It is well for us, however, to study carefully the economics of selection of types of pavements and to base our policies upon the results of such a study in so far as it is possible. We

all must recognize, however, that expediency sometimes compels policies which in the long run perhaps are of questionable economic value. The public today is a hard taskmaster for those appointed to take charge of highway improvement. In selection of a particular type of asphalt surface for a given project, therefore, it is not possible for us always to do the thing which to the best of our knowledge would result in ultimate economy.

The Progressive Plan of Highway Development.—During the past few years we have heard a great deal concerning the progressive development of highways. This plan has been selected in many sections as a logical solution of the highway problem. This plan generally is recognized as an expedient method of supplying public demand for extensive mileage of improved roads. Those who favor this plan hold forth the argument that a study of the economics of highway improvement is incomplete without including a careful analysis of the value rendered the traveling public by reducing transportation costs.

It is true without question that our development of highways is purely a transportation problem, and it is necessary therefore to consider the economics of highway development not only from the standpoint of highway expenditure. A study of the problem in its broad aspect must include a study of the service rendered. In sparsely populated communities especially a study of future traffic needs may disclose the necessity for a system of highways including a fairly large percentage of the higher types of pavements. Rather than immediately to start constructing pavements of that sort it is considered by many to be better policy to adopt the progressive method of highway improvement to the end that more people may be served in reasonable time than would be the case otherwise. If the community cannot bear the financial burden of securing the ideal result within a reasonable time, there appears to be a good argument for progressive development.

Stone Fill Through Rocky Cut Where the Drainage Is Complicated by Flow of Water in the Seams of the Ledges.

Use of Asphalt in Progressive Plan.—The wide diversity of types of asphalt surfaces makes it possible to carry out a comprehensive plan of progressive development of roads by the use of asphalt, progressing from the cheaper types to the more expensive types. In adopting this plan manifestly it is desirable so to carry out the program that there is a minimum waste in years to come when betterments in surfaces are brought about. Assuming that the initial im-

provement under a plan of progressive development consist of a gravel road, it is obvious that economy commends the securing of grades and alignments suitable for a more durable surface to be laid in the future. It is equally essential to have the initial gravel road properly drained and substantially constructed, so that there is no appreciable weakness.

For moderate traffic a surface treatment of bitumen over a gravel surface will serve the purpose very well for a number of years, provided proper maintenance is carried out. Perhaps the next step in progressive development would be the laying of a light macadam pavement over the gravel road to serve ultimately as a base for some higher type of pavement. For maintaining the macadam surface also bitumen applied for surface treatment will permit serving traffic very well. It is apparent, of course, that in laying the macadam surface care must be taken to have the cross-section conform approximately to the cross-section of the higher type of pavement to be selected at some future time.

The third step in development might be either an asphalt macadam surface or a bituminous concrete surface laid over the old macadam as a base. It may be on the other hand that one of the higher types of asphalt pavement is considered to be desirable as the second step. In the latter event a substantial gravel road serves admirably as a subgrade for a pavement, and its presence very likely will permit reduction in the depth of pavement which would be required otherwise.

It is seen readily that there is little waste in a progressive plan of development designed to employ asphalt surfaces in the manner described. The secret of success in this plan appears to be in carrying out each step of the procedure with careful consideration of the next step so that nothing need be thrown away. The bitumen applied as surface treatment to be sure is lost, but the cost of the surface treatment annually may be less than the interest on the investment for one of the most expensive types of pavement. If that is the case, there appears to be no economic loss.

Bituminous Surface Treatment of Gravel and Macadam.—The use of bitumens for surface treatment of gravel and macadam surfaces was one of the first steps undertaken t enable roads of that type to withstan motor vehicle traffic. Surface treat ment of these surfaces with bitume at present is widespread. Althougl for heavy travel, surface treated road are not considered to be practicable the method is looked upon with favo for roads carrying moderate travel especially by way of preservation o old roads. Provided there is no seri ous foundation trouble so that the sur face is not destroyed annually b frost action, a properly built grave road or a properly built macadan road, when surface treated, will stan up under a considerable volume o travel. Some deplore the plan o salvaging old roads by surface treat ment because of the expense o maintenance by this method. In man cases, however, it will be found tha adequate service may be rendered b adoption of this method at an annua cost no greater than the interest o the investment for one of the mor expensive pavements. For some rea son which is not clear, it is considere in many communities that it is de cidedly uneconomical to invest mone for maintenance. It is hard to pe ceive virtue in this argument when i is applied to salvaging existing road provided the expense is no greate than the interest upon the investmen necessary for construction of exper sive pavements which require littl maintenance. It is not fair, howeve to neglect to consider the character c service rendered traffic. Adoption c surface treatment therefore is hardl in order unless smooth surfaces con fortable to ride upon result.

Surface treatment of gravel an surface treatment of macadam a somewhat different problems. In su face treating a gravel road it appea to be essential to employ a bitume which has some penetrating powe and which therefore does not lay upo the top in the form of a mat. Exce lent results in surface treatment c gravel roads are secured from the us of cut-back asphalts which are ver fluid and which seem to acquire more intimate bond with the grav surface than do more viscous ma terials. In some localities the plan c using a priming coat of light materi of very low viscosity followed afte an interval of a few weeks by a trea ment with a heavier material favored.

The surface of a well built macada

road swept free from dust, ordinarily may be treated with excellent results with the more viscous asphaltic oils. It appears to be the sentiment now in most localities that the heavy asphaltic oils are more desirable for surface treatment of macadam surfaces than are the light dust laying oils used so commonly a few years ago. It is questionable, however if the use of the more expensive heavier products is desirable if the road surfaces are destroyed annually by frost action. Successive treatments of a well built macadam road not subject to foundation weakness develop with proper maintenance a surface capable of standing up under heavy traffic. The accumulative benefit of successive treatments cannot result if a road is weak so that the surface completely breaks up annually as a result of frost action.

Corrugation of surface treated roads is considered by many to be a serious defect characteristic of this type of surface. Ordinarily excessive corrugation is due to the selection of improper materials or to the accumulation of too great an amount of bitumen upon the surface. More frequent light applications of bitumen are considered to be more effective than less frequent heavy applications. Many times also it is considered good judgment to touch up spots where the surface treatment is defective rather than to apply to the entire surface a coat of bitumen which may result in an excess upon the surface and consequent corrugation.

Rhode Island Practice in Construction of Asphalt Macadam.—The technic of the construction of asphalt macadam appears to have received less attention than has the technic of the construction of the higher types of asphalt surfaces. Perhaps this may explain the prejudice upon the part of many highway engineers against this type of pavement. It is a fact that in many sections asphalt macadam has proved to be a very inferior type of surface, hardly preferable to several cheaper surface. On the other hand there are in the United States many instances of very economical service having been rendered by asphalt macadam pavements under heavy travel. In Rhode Island we have asphalt macadam pavements rendering economical service upon roads carrying a maximum daily traffic of approximately 10,000 vehicles per day and a daily average for the entire year of approximately 4,000 vehicles per day. Some of these surfaces are 10 years old, and are in excellent condition.

Asphaltic Concrete Surface Laid on Non-Rigid Foundation Over a Designed Sub-Grade.

Some of the faults characteristic of asphalt macadam pavements in many sections are corrugation of the surface and local raveling of the surface due to improper bond. Perhaps the most common fault, however, is foundation defect, which should not be considered necessarily as detracting from the merit of the pavement.

Excessive or progressive corrugation of the surface can be eliminated by careful selection of materials and by proper attention to numerous con-

struction details. Raveling of the surface also may be overcome. Although there are many highways upon which asphalt macadam is not desirable, it appears that asphalt macadam properly built will serve admirably upon a great many roads carrying fairly heavy travel.

The result of improper selection of materials for asphalt macadam pavements perhaps is more spectacular than is the case with some other asphalt surfaces, and the result is more quickly perceptible. We favor for the construction of asphalt macadam the selection of hard and tough stone. For very light traffic of course stone which is softer and less tough may be practicable. Since our practice of asphalt macadam construction contemplates that the stone in the penetration course will be subjected directly to the abrasion and impact of traffic, our reason for selecting hard, tough stone is apparent. We do not believe that an appreciable excess of bitumen upon the surface is desirable, so that it appears to us that a stone must be used which successfully will withstand the effect of abrasion and impact of travel directly upon it.

We believe also in the use of three sizes of crushed stone in constructing an asphalt macadam surface, each size to be screened between close limits. The stone into which the asphalt is introduced, which we know as the penetration course, is specified to be of sizes passing a 2½-in. screen and retained upon a 1½-in. screen. After the first penetration of the asphalt a smaller size of stone is selected to fill the surface interstices. We believe that this keystone, as it is called, should be of sizes which readily will permit the separate particles to enter the surface voids in the penetration course will not be so completely closed that the second application of bitumen, or the sealcoat as it is called, will not penetrate. Ordinarily we specify the keystone to be of sizes passing a 1-in. screen and retained upon a ⅝-in. screen.

After the application of the sealcoat we favor a cover stone of sizes smaller than the keystone so that the smaller surface voids remaining after the sealcoat is applied may be filled by the cover stone. Ordinarily we specify that the cover stone shall be of sizes passing a ⅝-in screen and retained upon a ⅜-in. screen.

The sizes of stone indicated above as the sizes called for in our specifications contemplate primarily the use of basalt and diabase. Occasionally the use of one of these rocks is not practicable, so that some other rock must be used. In that event, our sizes do not conform exactly to the sizes referred to above. We have no definite rule for correlating the sizes of crushed stone to the quality of the rock, but from our experience over a long period of years in crushing different types of rock which are common in our state, we are able to select the sizes which seem to work to the best advantage. Our best results have been achieved from the use of asphalt and diabase.

For asphalt macadam construction we favor the use of bitumens of penetration between 90 and 100. In some cases where our roads are canopied by trees we employ a material somewhat softer. If stability of surface is to be secured, we believe that the use of materials softer than 120 penetration should be eliminated.

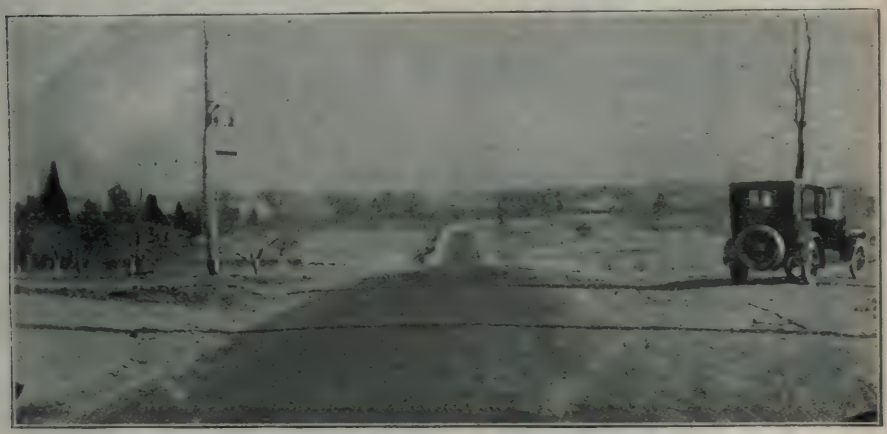
In the construction of our asphalt macadam pavements we also insist that the penetration course of stone shall be uniformity 2½-in. in depth. Below the penetration course we employ a base of crushed stone which is sand-filled, and which is of uniform depth from 2½ in. to 5½ in., depending upon character of foundations, upon character of subsoil and upon traffic. We do not believe in attempting to penetrate a single course of stone of depth greater than 2½ in. after compression because we feel that proper compression is impossible and because we feel that the asphalt finding its way below the 2½-in. level is of no practical value.

We favor the use of a liberal amount of asphalt. Our specifications provide for the use of 1¾ gal. of asphalt per sq. yd. of surface for the penetration course and from ¾ gal. to 1 gal. per sq. yd. for the sealcoat. These quantities are employed where basalt, diabase or similar rock is employed. Where a soft stone is used, we employ less asphalt because the breaking of the stone under the roller with the consequent reduction in percentage of voids is very apt to result in a soft pavement unless the quantity of asphalt be reduced. If the better qualities of stone are used we experience no difficulty from softness of pavement surfaces constructed with the amounts of bitumen referred to.

We feel that the importance of rolling asphalt macadam roads frequently is overlooked. Our base course of crushed stone always is rolled until there is no perceptible motion under the roller. The sand filler is applied in small quantities during the rolling operation so that it does not blanket upon the surface. We favor also heavy rolling of the penetration course of stone previous to the application of bitumen. Unless a soft stone is used which breaks up badly under the roller, we perceive absolutely no merit in the theory frequently advanced that heavy rolling of the penetration course of crushed stone previous to the application of the asphalt is injurious. We attempt to secure the maximum mechanical bond possible previous to the application of bitumen, so the asphalt serves primarily to intensify and preserve the mechanical bond.

Spreading the keystone is given great attention in our practice. The riding surface is no smoother than the surface at the end of the process of spreading the keystone. Bunching of the keystone results inevitably in an uneven wearing surface. The use of insufficient keystone to fill the voids results in an improper mechanical bond and an open mosaic surface which is subject to raveling. A wide brush attached to a frame fastened to the steam roller is found to be very effective in securing even distribution of the keystone at a nominal expense only.

After the application of the keystone, the pavement is well rolled before the sealcoat is applied. Subsequent to the application of the sealcoat, the pavement is rolled at intervals for at least one week. The final or back rolling we believe to be very essential in this type of construction. Subsequent to the initial rolling after the sealcoat is applied the periods during which our final rolling is carried out are the periods of the day during which the temperature is the highest and the pavement in consequence most plastic. If possible we prefer to open the pavement to traffic before the final rolling is completed. The effect of final rolling, together with the effect of traffic, appears to be more effective than does final rolling without traffic.



Mosaic Surface Typical of Asphalt Macadam in Rhode Island Practice for a Period of 1 to 3 Years After Construction.

We favor distribution of asphalt by one of many highly developed motor distributors. We do not favor gravity distribution. Distribution under high pressure we believe to be essential in securing uniformity in distribution and effectiveness in distribution.

Asphaltic Concrete Construction.—The technic of the construction of asphaltic concrete and sheet asphalt pavement is very highly developed. One cannot afford to deviate decidedly from the methods of construction of these pavements, which are well standardized. There are a great many types of asphaltic concrete so that no attempt will be made to discuss in detail each of the many types. Information concerning all of the types is readily available and in large part is dependable.

In the majority of types of asphaltic concrete it appears to be particularly essential to secure the maximum density which is practicable. It is particularly important to investigate carefully the grading of the fine particles in the mixture. It is generally considered desirable to secure a grading of sizes of particles passing a 10-mesh screen which conforms substantially to a standard sheet asphalt grading. Manifestly of course the proportion of material passing a 10-mesh screen must be correlated to the coarser particles in order to secure stability.

Recently intensive study has been made of the reason for corrugation in bituminous concrete surfaces and in sheet asphalt surfaces. It has been found that excessive corrugation of these surfaces in the majority of cases is due to the improper grading of the mineral aggregate, especially lack of filler, and to the use of asphalt of improper consistency. The use of excessive amounts of asphalt also is considered to be one of the causes of excessive corrugation. In preparing mixtures of these types it appears to be absolutely essential to correlate the asphalt binder to the mineral aggregate according to methods which are well defined.

Until very recently it has been considered generally that pavements of this type should be laid upon monolithic foundations. Recently there has been a tendency in many quarters to favor the use of resilient foundations. Excellent results frequently are secured from the use of macadam bases under the surfaces of both types. One of the finest examples of sheet asphalt in the city of Providence, R. I., is laid upon a macadam foundation. This particular pavement is in the neighborhood of 10 years old and is laid upon a narrow street which carries a car track in the center with the result that the heavy traffic passing over the street is more or less concentrated centrally between the car track and each curb. This pavement at present shows no evidence of fatigue.

The use of black bases, so-called, is a recent development. Arguments in favor of the use of such bases usually are that a resilient base of that character reduces the effect of impact to the surface and that it permits a more intimate bond to be secured between the surface and the base. Those who are in favor of bases of this type as opposed to monolithic bases argue that a monolithic base under the impact of travel in effect serves as an anvil to the detriment of the surface. The use of black bases is so recent that a large number of definite results based upon long years of use are not available. The writer is of the opinion that a monolithic base is preferable where the subsoil is unfavorable and where the traffic is concentrated in narrow channels by reason of the existence of car tracks in the street or for some other reason. It appears that the use of black base is desirable in many cases.

Sheet asphalt perhaps is better standardized than is any other asphalt pavement. The writer has no suggestions to offer in regard to the construction of sheet asphalt surfaces except to suggest following the best standard practice.

Maintenance of Asphalt Surfaces.—Ultimate success in the use of asphalt pavements depends as much upon successful maintenance as upon successful construction methods. There are many methods of maintaining each type of asphalt pavement and some of the methods perhaps are of questionable value. The function of maintenance is not only to preserve a smooth riding surface, but maintenance should be planned with the idea of securing from the pavement the maximum ultimate life which can be secured economically. Methods of maintenance which tend to destroy uniformity in the surface inevitably result in shortening the life of the pavement.

It seems logical to suppose, therefore, that repairs to pavement surfaces should be made with materials similar to the materials employed in construction, and that the methods employed in using the materials should be substantially identical with the methods adopted in construction. Repairing of breaks or cuts in bituminous concrete surfaces and in sheet asphalt surfaces ordinarily is taken care of by replacement with mixtures such as were used in the original construction. In maintaining asphalt macadam surfaces, however, it is common practice in many sections to employ only the simple and expedient method known as cold patching. Cold patching also is employed in some localities extensively for maintaining some of the cheaper forms of bituminous concrete.

The use of cold patches in asphalt pavements of the better type well may be considered as questionable practice except as a temporary expedient to take care of the situation until more permanent repairs may be made. Our department strongly favors the use of asphalt macadam patches upon asphalt macadam roads and upon asphaltic concrete roads where coarse, ungraded aggregate is employed. We decognize, however, that it is not always possible to put in a patch of this type as soon as a cut or break occurs. Therefore we use cold patches upon this type of surface only as temporary expedient until it is convenient to make a more permanent patch.

In our asphalt macadam roads patching of holes seldom is required except where cuts are made for the purpose of installation or repair of underground public utilities structures. Our repair of bituminous macadam roads consists very largely of light touching up of spots in the surface which are porous as a result of unequal distribution of the bitumen. For this work we favor using an asphalt of approximately the penetration used in the construction of the road. We believe that this practice tends to promote uniformity in the surface and thereby favors the securing of the maximum economical life of the surface. We do not favor for this local surface repair the use of light cold materials.

Cold patching appears to be particularly adapted for use upon surface treated gravel roads and upon surface macadam roads. For the repairing of breaks in either of these surfaces it is almost out of the question to attempt to restore the surface in the manner in which it was built.

A feature of maintenance aside from light repairs which is customary upon all types of asphalt surfaces, except upon sheet asphalt and similar surfaces, is resealing with asphalt at intervals of several years. It has been remarked previously that danger sometimes attends the practice of employing upon surface treated gravel roads and upon macadam roads too frequent applications of bituminous concrete surfaces. We have in our state bituminous macadam surfaces which are ten years old and which never have been resealed. The accumulation of excess bitumen upon the surface we believe is dangerous because it tends to promote corrugation of the surface and tends also to make the pavement excessively soft during warm weather.

We take care of local abrasions to the surface and of spots where the surface is porous for some reason by local treatment only. We can see little excuses for applying a sealcoat to the entire surface of the pavement simply because there as a few local defects. The tendency of asphalt in bituminous macadam construction is to flush to

A 7-Year-Old Asphalt Macadam Pavement.

the surface under the effect of traffic and the sun. Our asphalt macadam roads take about three years to arrive at a typical asphalt surface. To one who is familiar with asphalt macadam construction it is very apparent when resealing is necessary. In general it may be said that resealing is necessary only when the entire surface shows a tendency to become porous. Repairs to our bituminous macadam roads are taken care of by section gangs equipped with heating kettles and such other minor equipment as permits the use of hot asphalt.

What has been said concerning resealing of asphaltic macadam roads applies in general to resealing of asphaltic concrete roads. It appears to be true that many pavements of both types are injured almost beyond redemption by injudicious resealing. It is not always a case of too frequent or too liberal applications of bitumen to the surfaces, but it is sometimes a case of the use of improper materials. We do not favor the use of soft products for resealing the surfaces of either type. For resealing bituminous concrete surfaces we favor the use of a paving cement of from 60 to 70 penetration. For resealing of bituminous macadam surfaces we favor the use of an asphalt of penetration between 120 and 150. Ordinarily we employ machine distribution of materials employed in resealing asphaltic macadam surfaces. For resealing bituminous concrete surfaces we favor the squeegee method because it appears to be difficult to secure a uniform distribution sufficiently light by motor distributor.

The amounts of material used for resealing should depend upon the character of the surface which is treated. It is our intention not to form a mat upon the surface but to make the surface water-tight by filling the small voids in the surface which may develop under traffic.

It would seem that one of the common faults in maintaining asphalt surfaces of the higher types is that sufficient thought is not given to the question of prolonging the life of the pavement, but the immediate demand for a smooth surface is supplied in the most expedient way only. In general attention to the plan of designing maintenance methods to the end that maximum life of the pavement may be secured is considerable to be desirable.

In conclusion the writer desires to state that this broad subject of course has not been treated thoroughly in this paper. The writer intends in this paper to dwell chiefly upon features of asphalt pavements which sometimes appear to be overlooked, and perhaps thereby to supply food for thought to those who have occasion to supervise the construction and maintenance of asphalt surfaces.

Construction of Monolithic Concrete Culverts

Methods Employed by the Maintenance Division of the North Carolina Department of State Roads and Highways Described in North Carolina Road Bulletin

By I. H. BOGGS and C. L. TINDALL
Resident Engineer North Carolina State Highway Department

Portions of Projects No. 200 and 201 in Carteret County, North Carolina, cross tidewater swamps where bridges are unnecessary and where the flow can be accommodated by large culverts. The water in these swamps is salt. For a long time it has been an accepted fact that salt water is detrimental to concrete. No method of contsruction nor consistency of mix has yet been found that is guaranteed to completely withstand salt water. It is believed, however, that dense concrete and few if any construction joints will go a long ways towards making concrete impervious.

Eleven culverts on the above named projects are under construction in salt marshes. By a special order from the Bridge Department, these culverts are being constructed of Class "A-A" concrete (1:1½:3 mix) and are being poured as a monolithic structure.

The usual way of pouring a concrete culvert—footing first and barrel and headwalls after the footing has set up—is generally known. The monolithic culvert is rather uncommon and the mode of construction may be noted with interest. The general scheme of construction that is employed by the contractor on Projects No. 200 and No. 201 for building monolithic culverts is a combination of ideas of all concerned as no

one on either project had ever seen a monolithic culvert built.

The Foundation Work.—Unfortunately, there is not a stable foundation in any of the salt marshes. First, therefore, it is necessary to drive bearing piles to carry the load. Incidentally, these piles are of great assistance in the construction of a timber floor which has to be built under the entire footing of all the culverts.

The footing of an ordinary culvert, where conditions demand, may be floored with pine slabs or other cheap lumber, then the footing poured and allowed to set up before the rest of the structure is completed. The footings of these monolithic culverts, however, must be floored with timber of sufficient bearing capacity to support the weight of the entire structure until the concrete sets up and the loan is transferred directly on the piles.

After the piles are driven, the excavation is shaped up and carried to an extra depth of about 8 in. to admit the floor stringers which are spiked to the piles. The floor is built with rough timbers the size of which varies with the span of the culvert. The floor under the barrel is made sufficiently wide to permit the side-wall forms to rest on it.

The Forms.—The entire set of forms for the culvert is built in place on the floor and bolted together on the inside. The box form is supported above the floor a distance equal to the thickness of the floor-slab by 1 in. by 2 in. strips that are nailed to the studding inside the form. (When the box form is removed from the completed culvert, these 1 in. by 2 in. strips are knocked loose from the studding and cut off flush with the floor-slab.) Planks for the top of the box, or that part which supports the top-slab of the culvert, are cut and fitted but not put in place until the footing and half the wall have been poured. Access to the footing while the concrete is being poured is thus permitted.

The Reinforcement.—The steel for the footing is wired together in mats and laid on the floor before the barrel form is set in. It is supported in its proper position by being laid on precast concrete blocks or suspended by wires from the stringers in the box form. This steel is best supported by the concrete block or suspended by wires from the stringers in the box form. This steel is best supported by the concrete blocks. The blocks become completely imbedded in concrete, whereas, wire can be cut off only at the surface of the slab, thus permitting an attack for salt water.

Steel for the top slab is wired together, usually in two mats, and laid in the wet concrete after a 3 in. layer has been poured on the top of the box.

Suspension of the steel in the walls offers no particular difficulty if the brace-wires running through the walls are so placed that they coincide with the horizontal steel. The horizontal steel may be fastened to the brace-wires and the vertical steel in turn fastened to the horizontal.

Placing the Concrete.—After the forms are completed and the steel is in place, the greater part of the job is done. Pouring the concrete is comparatively simple and means nothing more than a good, long day's work. With ample material at the mixer, a good supply of fresh water, and an early morning start, an 8 in. by 4 in. culvert is completed in 12 hours with a 1-bag mixer. In cool or moderately warm weather the footing may be poured throughout the entire length of the culvert before a layer in the walls is started, but, if the weather is hot, care must be taken to add a shallow layer of concrete in the walls as the footing progresses. If this layer is not added, the first concrete poured in the footing will have obtained its initial set before the footing is completed and the wall started.

Rubbing of exposed surfaces to remove board marks left by the forms is not permitted. It is believed that concrete is more impervious when the surface is not disturbed by rubbing. A good finish is obtained by first oiling the forms well before the concrete is poured and then tapping the forms lightly with a hammer as the concrete is placed to assure a film of mortar next to the forms.

It may be said that monolithic culverts are no more difficult to build than ordinary culverts. They are more expensive, however, because of the necessity of building a strong timber floor, the extra work in suspending the steel and numerous other extra details the explanation of which is not permitted here because of limited space.

Great care in every detail is being maintained in the culverts. Only time will tell whether or not monolithic construction is going to lengthen the life of these structures in salt water.

Highway Equipment Accounting

Method Employed in North Carolina Tidewater Swamps Described in North Carolina Highway Bulletin

By R. F. ALBERT,
Assistant Engineer of Maintenance

In the maintenance of roads all kinds of equipment, varying in size from small tools, such as picks, shovels and brooms, to larger equipment, such as graders, tractors and rollers, are necessary. The roads upon which this equipment is used being scattered throughout the state, it follows that the equipment is just as widely scattered and some very accurate method must be used to properly account for each article.

M-132 DUPLICATE
Commonwealth of Kentucky
DEPARTMENT OF STATE ROADS AND HIGHWAYS
Superintendent's Equipment Report
District..... Sheet.....of.....
Subdistrict.....Month Ending.....192....

Articles No.			REMARKS
Road No.			
Section			
Axes			
Bars, crow			
Bars, pinch			
Drills			
Drags			
Total			

Approved:..... Submitted.....
Dist. Engr. Dist. Supt.

State Divided Into 6 Districts.—For the purpose of administration and field supervision the state is divided into six districts, at the headquarters of each is the district office, where are kept equipment records pertaining to that district. In turn, each district is divided into sub-districts with a superintendent of maintenance in charge of each. He keeps all records pertaining to the various articles of equipment assigned for use on the roads in his sub-district and in storage at sub-district headquarters.

To properly account for the equipment both in use and storage, three forms are used.

Forms for Accounting for Equipment.—First, the patrolman's, foreman's or resident superintendent's form, M-13, upon which, at the end of each month, is listed the equipment actually in use on that project. There is provided a column for "Remarks," under which is noted any increase or decrease in the number of each article of equipment. This form is forwarded to the superintendent of maintenance, who checks up the report, using the previous monthly report submitted from that project and any data he has pertaining to the assignment or release of any equipment. Second, the district superintendent then compiles Form M-132 from the data contained in all reports from the patrolmen, foremen and resident superintendents. After such data is compiled, the list of equipment in storage in the sub-district is listed immediately following. Upon the receipt of this form at district headquarters, it is checked with the information contained in the previous monthly report, and such data pertaining to assignment or release of any equipment in that sub-district. A copy of each sub-district report is retained in the district office, the originals being forwarded to the equipment engineer at the central office. On one of the originals is shown the equipment in storage at district headquarters.

Third, from the information contained in the superintendent's equipment report, Form M-134, equipment record is compiled. This record is kept in the district office for that district and in the central office for each district. The form is designed to show the balance on hand of each article of equipment at the beginning of the month and the number of articles both assigned to and released from each district. The details pertaining to each transfer are shown on Form M-132. An accurate account is kept in the central office of all equipment

M-133 DUPLICATE
Commonwealth of Kentucky
DEPARTMENT OF STATE ROADS AND HIGHWAYS
Patrolman's Equipment Report
Sheet.....of.....
To District Superintendent:
Following is the equipment in use on Road..... Sec..... Dist.....
Sub-Dist.....For month ending .....192.....

Article No.			REMARKS
Axes			
Bars, crow			
Bars, pinch			
Brooms			
Drills, churn			
Tractors			
Rollers			
Autos, state owned			

Patrolman
Foreman
.....

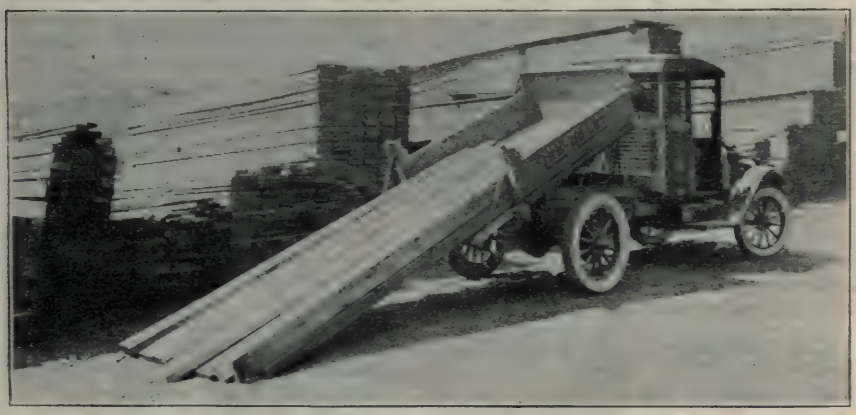
purchased for the districts and sent out from the state garage, and reports received each month are checked against these accounts.

By this method it is possible to know at all times the number of articles of any kind of equipment in a district, the location as to project of all equipment and the amount and kind of equipment not in use. It saves much time and expense in locating equipment, prevents its loss through neglect and prevents unnecessary expenditure for new equipment.

The Forms.—There are forty or more items listed on the standard forms Nos. 132 and 133, but in printing here all but half a dozen have been omitted to reduce the space necessary and still show an outline of the form.

Hauling Lumber in a Dump Body

In construction work there is often as much lumber to be hauled around and to and from the job as there is sand and gravel. Hauling lumber in a dump body is nothing new. To do so successfully, however, it is desirable that the body be equipped with a double-acting end gate both for the purpose of holding a larger load if necessary and also to provide an additional floor area in the body so that longer lengths can be carried. If loaded properly lumber is just as easily dumped out of an automatic dump body as any other kind of material, as shown in the photograph. The Indiana Harbor Lumber & Coal Co., which does a lot of hauling for road and building contractors, has gone a step further and is operating a body built in such a way that extra long lengths of timber and plank can be handled successfully. This consists of a dump body provided not only with a double-acting tailgate at the rear, but a single-acting tailgate also at the front end. The body recently put into operation by the Indiana Harbor Lumber & Coal Co. is an automatic dump body built by the Lee Trailer & Body Co., Chicago, and has no obstructions such as a hoist or anything of that kind between the cab and the front end of the body, therefore the load can be shoved up flush against the cab, and in the case of very long lengths can be loaded in the extreme sides of the body so as to extend alongside of the cab.



Automatic Dump Body Used by Indiana Harbor Lumber & Coal Co. in Hauling Lumber.

Common Labor Wages in Road Field

The following figures based on the bid prices received during the week ending Sept. 15 for Federal Aid road construction, show the average hourly wages of common labor prevailing at the places mentioned:

	Per Hour
Rabun County, Georgia	17½c
Richmond County, Georgia	20c
Henry County, Iowa	35c-40c
Anderson County, Kansas	35c
Sabine County, Louisiana	20c
Berkshire County, Massachusetts	60c
Rolette County, North Dakota	45c
Aiken County, South Carolina	17½c

The Care and Use of Steam Road Rollers

Suggestion of English Engineer on Operation, Maintenance and Repair Given in Paper Presented Before the Institution of Municipal and County Engineers (England)

By MAJOR G. W. G. ALLEN

It lies within the power of the driver to vary the running cost considerably. The most economical method of firing, with a boiler that steams considerably well, is to have a thick fire, care being taken that the firebars are always evenly covered. Holes in the fire allow air to pass, causing variation in temperature, and are a frequent source of tube and stay leakages. Only in cases where a boiler steams badly should a thin fire be permitted. Apart from the saving in fuel, a thick fire stresses the firebox plates less, as the heat is more evenly distributed.

Coal.—It is very false economy to use poor coal. A good steam coal is cheaper in the long run. Buckled firebars should be renewed at once. Apart from the wastage due to large coal falling through, the ashpan will soon be deteriorated through excessive heat.

Boiler tubes should be frequently swept. Ashes should not be allowed to accumulate in the bottom of the smoke box. When the engine is not being used the fire box and smoke box should be carefully cleaned out, otherwise wastage of the tube plate and smoke-box will take place.

The boiler should be washed out frequently, at least once in every 100 hours' working; this will prevent scale forming, avoid the risk of fire-box plates being burnt, and the valve and cylinder faces being cut as a result of priming.

The injector and pipes should be frequently cleaned out. Scale can be removed from the injector by soaking in dilute spirits of salts. Particular attention should be paid to keeping the injector steam-cock and boiler clack-box tight; most injector troubles can be traced to leakage at these points, causing furring up in the injector.

Waterlift.—Leakages at the steam-cock of the waterlift may cause heating of the water in the tank, and render the injector difficult to operate.

When the roller is out of use for a considerable period coal should be removed from the tender, as, if allowed to get damp, it sets up rust, and rapidly deteriorates the sides and floor of the coal bunker.

Pump.—The passage between the pump body and the boiler should be kept clear. This soon becomes furred up, and the hole reduced in area, causing an excessive strain on the pump.

Water-gauge Fittings.—The average type of water-gauge fitting is difficult to keep in order. If neglected, the water level shown may be unreliable, and trouble caused owing to shortage of, or excessive, water. The most satisfactory water gauge is the needle-pointed type, with cone seat and packed gland, which remains tight indefinitely, and has the advantage of being easy to operate in the event of the glass breaking.

Lubrication.—It is false economy to buy low-grade oil. Little and often should be the maxim for the driver. Make sure that the oil actually reaches the bearing. Oil pipes often get blocked up with thick oil. Particular attention should be paid to the inner bearings of front rollers; they are somewhat inaccessible, and, owing to the camber of the road, take the majority of the load on the front of the roller. The hind axle bearings are very heavily loaded and slow moving. If oil fails to reach them very considerable damage may be caused before the trouble is discovered. The old type displacement cylinder lubricator is unreliable, generally allowing its charge of oil to run direct into the cylinder instead of feeding the oil in gradually. A mechanically operated oil pump will effect a saving in the quantity of oil used, and increase the life and efficiency of the slide valve and piston.

Boiler.—Boiler tubes should be removed periodically, thoroughly scaled, and the inside of the boiler cleaned out, the tubes annealed and replaced. Apart from economy during running time, if this is done the engine will steam more quickly when getting steam up. When the tubes are out the throat plate and flanged front-casing plate should be examined for grooving, which occurs in some cases.

Exhaust Pipe.—One of the most prolific causes of fire box and tube trouble is a furred-up exhaust pipe. The hydro-carbon cylinder oils now used pass through the cylinder with the exhaust steam, and the interior of the exhaust pipe becomes sticky with oil. When the engine is reversed, while still in motion, a puff of smoke and ash dust is drawn into the exhaust pipe; this adheres to the oily skin in the pipe, and gradually contracts the internal area. It is not uncommon to find the bore of the pipe reduced to 1 in. diameter. This throttles the exhaust, causes back pressure on the piston, loss of power, uses more steam, and puts additional blast on the fire, thereby using more fuel and water. Exhaust pipes should be frequently removed and cleaned.

Link Motion.—It is seldom realized what a great effect slight wear in the link motion will have on the travel of the valve. The average link motion and reversing gear on a single-cylinder engine has six pins. Quite a small amount of play on these pins may reduce the lead of the valve by 1/16 in. or more, and if the lead of the valve is reduced there is no cushion to stop the piston and other reciprocating parts at the end of the stroke, and the cut-off is correspondingly later, giving less expansion and a higher terminal exhaust pressure, which means less power developed and higher consumption of coal and water. With modern hardening and grinding appliances, the repair of link motion is not a serious matter, and renders complete renewal of these parts unnecessary. Although an engine will run with its link motion badly worn, the loss of economy is more serious than is generally realized. Most valve-spindle breakages are due to worn link motion.

Lagging.—The lagging should be removed periodically, and the boiler barrel thoroughly cleaned down, painted with non-corrosive paint, and fresh lagging fitted. Apart from conserving the heat, this will give an opportunity for inspection of the boiler plates, discovery of leaks, pitting and prevention of corrosion. Material damage often occurs to boilers through neglect. It is surprising how quickly local wasting will occur in tht neighborhood of slight leaks if the latter are not attended to.

Roller Wheels.—One of the most serious expenses of roller maintenance is the wheels, and likewise the greatest economy can be effected in their upkeep. If the rims are not worn too thin, say, not less than 1¼ in. for hinds and 1 in. for fronts, they can be plated with wrought steel plates, when they will wear approximately three to four times longer than new cast-iron wheels, and furthermore, they can be subsequently replated. The camber of roads is different in various districts. Generally, in the case of cast-iron wheels, no provision is made for the wheels to fit the camber of the roads in the district where the roller is working. The initial wear of cast-iron wheels while they are adapting themselves to the camber of the road is rapid. When wheels are plated the camber of the worn cast-iron wheel is retained, and consequently plated wheels have a full bearing on the road from the start.

Material for Rims.—The great difference in the life of cast-iron and stel is due to the following reason: On coming in contact with a sharp stone a small piece is chipped out of the cast-iron surface and disappears; with a wrought-steel surface the metal is merely displaced, the portion moved ultimately becoming flattened down again. The difference in the nature of these metals also accounts for the fact that a steel-plated wheel has less tendency to slip than cast iron. This is particularly noticeable in hilly districts and when scarifying. Cast-steel wheels are more expensive, and if hard enough to resist wear, soon polish and become smooth; consequently, they will not grip properly, and are altogether unsuited for hilly districts, or where rollers have to travel over square setts.

Electric Welding.—Electric welding

has opened up great possibilities of repairs. Parts can now be made as good as new, when in the past they would have had to be scrapped. Local thinning of fire boxes and tube plates can be built up; cracks running from fire-box stays can be welded; worn shafts made good and damaged key ways repaired; broken castings and brackets welded; worn fork heads built up; broken teeth in gear wheels replaced, etc. In some cases loose spokes welded into wheel bosses, etc.

Keep Bolts Tight.—Loose bolts are often the cause of breakdown. Every engine should be examined frequently and all loose bolts tightened up. Loose bolts will allow wear to occur in the bolt holes, the parts depending on them to get out of register and wear. Throughout the engine wear begets wear.

Scarifiers and Their Effects.—Hind axle bracket and tender bolts require careful attention, particularly if the roller is used for scarifying. With independent scarifiers all the strain comes on these bolts. Some scarifiers rely mainly on the tender, which is the weakest part of the roller, for support. Tractive strains should be taken directly from the main axle and horn plates, and the tender insulated from vibration and shock as far as possible. Scarifying at the best is a trying operation; the scarifier and connecting parts should be kept in as good condition as possible. Dither and vibration from within the scarifier should be reduced to the minimum. Frames composed of channels and plates riveted together will allow vibration if the rivets are loose. Backlash or lift in the operating gear may be another source of similar trouble. To deal with the exceedingly hard and tenacious road surfaces of today scarifiers and their attachments should be made and maintained as rigid as possible.

Replacement of Parts.—In the replacement of worn parts it is not always the soundest economy merely to put in a new part of the original type; in many cases improvement of design can be effected. As an example, cast-iron, steerage quadrants, which fracture easily, may be replaced by wrought steel, which is practically unbreakable. In some makes of engines two gear wheels are made in one piece, one wheel of which will have more use than the other, and consequently wear out sooner. Economy can often be effected by parting the gears and replacing only the worn one. This also applies to those engines in which the smoke box and boiler barrel are in one length. It is usually possible to cap a new smoke box on to the tube-plate joint without renewing the front-boiler barrel plates; this obviates the necessity of refitting the cylinder, etc.

It is unwise to put standard rings into a worn piston or cylinder. The piston-ring grooves wear on the sides and become shouldered; they should be faced up and winder rings fitted. Cylinders wear oval; replacement rings should be made oversize and bedded by hand to suit the worn conditions.

Steerage.—Speaking generally, steerage gears require little attention. A simple, but not commonly known, means of increasing the life of a worn wheel is to remove it and replace it half-way round. This brings the least worn area into use.

General Remarks.—The maintenance costs of steam rollers vary considerably. A careful driver, who knows his job and takes a pride in his engine, prevents breakdowns and reduces costs of maintenance.

Rollers working in hilly districts, or having to travel considerable distances to and from work, or which use bad water, are the most costly to maintain. One days hard traveling will take more out of a roller than a months' ordinary work. It is a mistake to hurry a roller when traveling. Although it is obvious that scrapers should be slacked back when traveling, this frequently is not done.

A steam roller by makers of repute and well cared for has a life of very many years.

Highway Construction in Connecticut.—At a total cost of $3,597,401, an aggregate of 147.65 miles of highway were constructed and accepted by the State Highway Department of Connecticut during the fiscal year ending July 1. This figure only embraces the contracts completed. In addition, on July 1, total mileage under construction amounted to 101.92 miles, at a total cost of $4,129.204. On July 1, 1922, there were 136.14 miles under construction representing an approximate cost of $3,940,975.

Selecting the Responsible Bidder

To define responsibility as applied to construction companies and to devise a practical means of selecting responsible bidders for a given project, is the task that has been undertaken by the Committee on Ethics of the Associated General Contractors. By this procedure, in which, it is believed, engineers and public officials will recognize a benefit to the industry, the association desires to remove the disagreeable controversies that frequently result when engineers disqualify an irresponsible bidder.

In the co-operative work which the Association has been doing with the Joint Conference on Contracts, the American Association of State Highway Officials, the Interdepartmental Board of Contracts and Adjustments, and various local agencies, almost every issue discussed has appeared to have some connection with this question of responsibility. The opinion has been frequently expressed by engineers and public officials that they would be glad to adopt certain contract principles, if they possessed the means for awarding contracts only to responsible companies. Some of these principles they are unwilling to adopt as long as they are practically obliged to award their contracts to any irresponsible company that can furnish a bond.

If these expressions mean their true convictions, that engineers and public officials do actually desire to eliminate "piker bids" and deal only with responsible companies, work along this line may reasonably be expected to result in a gradual easing up on the drasticness of contract provisions and a much higher regard for the construction business on the part of clients and professional men.

The Federal Government has, on special work, used the policy of receiving bids only from companies who could demonstrate their ability to execute the work, and a like procedure has been used on highway work in Kentucky and on the construction of flood prevention work in Mississippi. It is commonly believed that public officials would favor the adoption of some plan whereby they could eliminate irresponsible bidders if they were able to do so without entailing a political fight, a taxpayer's injunction, or other unpleasant features attending the disqualification of a bidder.

Probably the most effective means of doing so is that adopted by the Treasury Department in requiring bidders to show their qualifications before they are given plans for estimating. If the Association can devise some practical plan whereby engineers, architects, and public officials can ascertain the responsibility of any company with respect to a given project, many difficulties on both sides may reasonably be expected to disappear.

The Committee on Ethics, in undertaking this important piece of work, is desirous that construction companies throughout the country give it their careful thought, and forward to the Washington office any suggestions bearing on the issue.

The following outline of points involved in the question of responsibility is offered for discussion:

Elements of Responsibility

1. Financial Strength.
   a. A financial statement to indicate the condition of the bidders business. (A. G. C. Financial Statement.)
   b. Statement of funds available for the project.
   c. Banking reference.
2. a. Personal experience of construction manager, proprietor, partner or company official in charge of construction.
   b. Experience of superintendent now in employ of company, who is competent to execute the work.
   c. Experience of superintendent (if not one of the above) who is to be placed in charge of work.
3. Construction Plant Available for Project.
   a. Equipment Owned.
   b. Equipment that will be rented or purchased.
4. Construction Performance Record.
   a. Projects similiar in character to the one being let.
   b. Projects of any other nature.
   c. Projects uncompleted through default.
5. Personal References for Successful Construction Service.
   a. Client owners.

b. Practicing Engineers and Architects.
c. Public Officials.

Qualifying Bidders

Qualification of Bidders Before They Are Allowed to Submit Proposals, Instead of After Bids Are Received:

1. Relieves department from the criticism entailed when it rejects the bid of an irresponsible company that may be low.

2. Removes principal ground upon which a disqualified bidder can secure a taxpayer's injunction—namely, the award of a contract at a higher price.

3. Qualification can probably be handled more judiciously by the department when bidders have no checks on deposit and no proposals in the possession of the department.

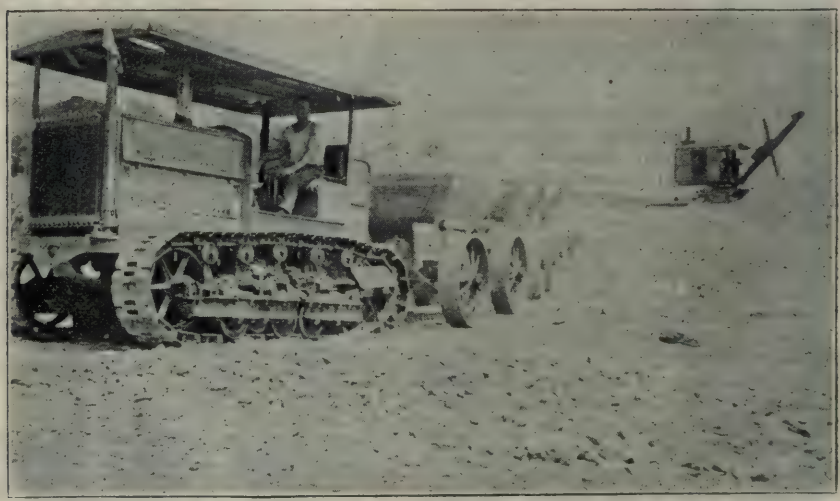
4. The expense of field investigation and estimating is saved to the bidder who cannot qualify for a particular project.

5. Disqualification would probably receive less publicity and create less resentment in the disqualified ones.

6. With the issue of bonding not yet raised, the department would doubtless be free from pressure of bonding companies in the matter, and also from the influence of politicians or officials who might be interested in the placing of the bond.

Tractor-Trailer Operation on Virginia Road Job

Some interesting tractor-trailer operations are being carried out by Boxley, Chisholm & Hall, Roanoke, Va., in building 7 miles of bituminous macadam road in Botetcourt County, near Troutville, Va. The road is being constructed with a hard surface 18 ft. wide with a 4-ft. shoulder on each side. The company owns and operates on this job one Caterpillar 10-ton tractor and four model RS-4 Troy slow-speed trailers. In a little more than two months of actual operation it has built more than 2½ miles of road. This road is constructed from No. 1 and No. 2 crushed rock. The road bed is covered with No. 1 stone and thoroughly rolled and the No. 2 rock is placed on the top. The trailers are loaded with a steam shovel and instead of normal 3½ cu. yd., which they are supposed to carry, each trailer carries 4½ cu. yd. of stone. The train is drawn by the tractor over the prepared subgrade to the beginning point. The trailers are placed on the right-hand side of the grade, the tractor disconnects and returns to the opposite end of the train, connects up again and begins moving in the direction from which the train has just come, but at a very slow speed. The trainman trips the spreader doors of the trailers, beginning with the trailer



Loaded Train Proceeding to Place Where Rock Is Spread on Prepared Subgrade.

next to the tractor, then opening the next when the first has discharged its contents, and so on until the entire train load has been spread in a 6-ft. strip at the right-hand side of the grade. The next train load is spread in a like manner on the left-hand side of the grade, and a third train load is spread down the center, thus completing the 18 ft. strip and leaving but a trifling amount of hand leveling to be done. The train load with the No. 2 stone is drawn over the spread of No. 1 to the beginning point and the operation is repeated until the small aggregate is evenly deposited on the larger, and it is then ready to receive the binder.

Tractor Disconnecting to Connect Up at Reverse End to Begin Spread at Center of Road.

California Highways.—According to a census by the U. S. Bureau of Public Roads, California now has 44,775 miles of improved road, not including that added during last season. The total road mileage of the state is 75,889 miles, as compared with 61,039 miles in 1914, and during the 7-year period from 1914 the surfaced and paved roads have increased from 10,280 to 14,275 miles. The total income for highways in 1921 amounted to $49,691,895, or $319 for each square mile of area, $655 for each mile of road, or $14.50 per capita.

Cost of Highway Maintenance in Kentucky in 1922

During 1922 the Department of State Roads and Highways of Kentucky spent $734,000 for maintenance proper, betterments and reconstruction on over 1,000 miles of various types of road that had been taken over for maintenance by the state. The following details regarding the work are given in the Kentucky Road Builder by R. F. Albert, assistant engineer of maintenance:

Analysis of the expenditures is outlined below:

Surface treatment	$200,546.15
Reconstruction waterbound macadam	200,546.15
Reconstruction gravel surface	68,112.77
Maintenance proper	280,777.40
Equipment	20,785.28
Administration	19,632.20
Total	$734,026.56

The money expended on surface treatment where initially applied to a road is not properly considered as maintenance, but as a betterment. Also money expended on the reconstruction of waterbound macadam and gravel surface is not a problem of maintenance, but merely the rebuilding of wornout roads of these types. The reconstruction costs are, therefore, not considered in arriving at the

cost of maintaining per mile of each type of road shown below:

Maintenance Cost Per Mile (All Items Included)

	Miles	Per Year
Grade and drain	186.71	415.23
Gravel	71.48	389.88
Waterbound macadam surface treated	372.35	797.64
Rock asphalt	53.36	387.84
Concrete	18.63	327.73
Bitumious macadam	26.52	240.00
Brick	3.89	344.25

It will be noted that the cost of maintenance of the higher types of roads is rather large, but it must be remembered that maintenance includes cleaning of ditches, keeping drainage structures open, repairing and painting of drainage structures, erection and repair of guard railing, cutting and removing weeds and undergrowth, trimming of trees, erecting and painting safety and mileage signs, removing slides, repairing damage done to road bed by high water and heavy rains, and heavy traffic, as well as repairs to the surface of the road. The latter item is the one deserving the most serious consideration after the road bed becomes thoroughly settled, for over a long period of years this will be the largest factor with which maintenance deals.

Cost of Surface Maintenance (Per Mile Year)

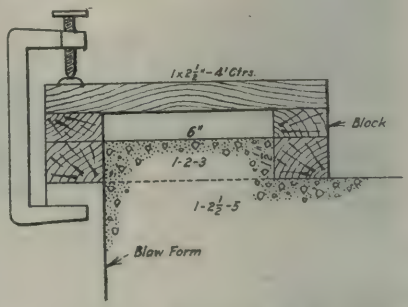
Grade and drain	193.70
Gravel	296.10
W. B. M. surface treated	344.09
Rock asphalt	98.70
Concrete	179.00
Bituminous macadam	116.00
Brick	29.95

No definite conclusion can be drawn from the above figures in arriving at the average cost of maintaining a mile of the various types of surface over a long period of years, since these figures are merely the cost incurred during the year 1922. More definite costs are determined by taking the average yearly costs of various roads extending over a period of years covering the time from the construction of a road to its reconstruction.

Method of Constructing Integral Curb

An interesting method of constructing integral curb was employed by Melzel, O'Hearn, Vastine & Lewin on this contract for Federal Aid Project No. 57-A in Knox and Bell counties, Kentucky. This contract covers 12½ miles of the eastern Dixie Highway between Barbourville and Pineville. The work consists principally of concrete base and integral curbs with Kentucky rock asphalt surface, the grading having been done last year under another contract. The base is 6 in. thick, 16 ft. wide, except on curves, which are increased to 18 or 20 ft. of 1:2½:5 concrete unreinforced. The curbs are 6 in. wide, of 1:2:3 concrete extending 1½ in. above the base. The rock asphalt surface is 1½ in. thick after compression, finishing flush with the top of the curb. The amount of the contract will approximate $400,000.

The method of constructing the curb is described as follows in The Scraper: A portable box is carried along each side of the road and into which a batch of the 1:2½:5 concrete is dumped as required and to which additional cement is added to make



Arrangement of Wooden Form for Integral Curb.

the 1:2:3 mix. The curb is made by the use of wooden forms built in 12 ft. sections and clamped to the Blaw-Knox forms as shown in the accompanying sketch. The wood form is light enough to be easily handled and is sufficiently flexible to be accurately adjusted to alignment. The curb concrete is placed in the wood form by hand and trowel finished. By this arrangement no difficulty or delay whatever is experienced in forming the curbs.

When the concrete base has partially set and before the curb forms are removed, the surface of the base is scored in three directions by the use of a hand-drawn corrguated roller. The corrugations are about 2 in. apart and extend into the concrete about ½ in. By pulling the roller across the pavement in three directions a very uniform and positive scoring of the base is secured.

Construction and Maintenance of Bituminous Macadam

Practice in Massachusetts Described in Paper Presented Before the Northeastern Section, American Society of Civil Engineers

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Before going into the details of the construction, it will be well to define what is meant by a "Bituminous Macadam Road," to consider briefly its history and to enumerate the different types.

The definition adopted by the Association for Standardizing Paving specifications is as follows: "Bituminous macadam pavements are those consisting of broken stone and bituminous material incorporated together by peneration methods."

The peneration type of road is comparatively new, having come into popular use during the last 15 years. Its popularity was due to the fact that the automobile was fast destroying the old waterbound macadam roads and a binder other than dust and water was necessary. During the period from 1908 to 1911 the increase in yardage of this type in Massachusetts and six other states was one hundred fold. To Massachusetts, perhaps, as much as to any other state belongs the credit for this pioneer work, and it may be considered pioneer work, for this type was still in its experimental stages up to 1912, at which time our standard type of peneration was developed. It can be safely said that up to this time heavy asphalts had not been sprayed by distributors under pressure. Lighter materials had been used and the work was done by hand or other crude methods.

Types of Bituminous Macadam.—There are three different types of bituminous macadam pavement which have been developed in Massachusetts, as follows:

(1) Bituminous macadam hot oil. (Used previous to 1912.)

(2) Johnson type. (A tar penetration.)

(3) Massachusetts standard type No. 1 stone. (Both tar and asphalt used. Developed in 1912.)

The first type, the bituminous macadam hot oil, is not considered a modern type and is no longer being built, but 35 miles of it are still under maintenance in Massachusetts.

This type was laid during the experimental days up to and including 1911. It was constructed by spraying about ¾ gal. per square yard of 90 per cent asphaltic oil on top of a waterbound macadam base or a gravel base—then about 2 in. of No. 2 stone was spread evenly over the oil blanket and rolled into the oil with a steam roller. Next, ¾ gal. per square yard of the same kind of oil was sprayed into the No. 2 stone and later covered with sand and pea stone and then rolled. Sometimes, if necessary, a light seal coat of about ¼ gal. per square yard was further applied and again covered with sand and pea stone.

The second type is the "Johnson type," so-called because it was developed and has been extensively used by John A. Johnson, district engineer, Division of Highways in the Massachusetts Department of Public Works.

Briefly, it consists of first laying a carefully prepared stone base of ledge of field stone—the larger stones being placed on the bottom and chinked up and brought to grade with smaller stones so that after rolling and having the voids filled with sandy gravel, the surface of the stone base shall be 2 in. below and parallel to the proposed finished surface of the road.

Then 2 in. of No. 1 stone is spread on top of the stone base, rolled and covered uniformly with about 1/100 cu. yd. per square yard of clean sharp sand, so that after rolling again the sand fills the voids in the stone about halfway to the surface.

Next, the stone is lightly sprinkled with water, and tar having a consistency of 70 to 120 by the float test, is applied under pressure at the rate of ¼ gal. per square yard. No. 2 stone is next spread uniformly over the bitumen at the rate of 0.02 tons per square yard and the surface is rolled. The surface is then sprinkled again, and tar, at the rate of ½ gal. per square yard is sprayed into the

No. 2 stone, and the surface is covered with pea stone and rolled.

Finally, the surface is sprinkled for the third time with water, and a seal coat of ¼ gal. per square yard of tar is applied, and then covered with clean, coarse sand and thoroughly rolled.

The third type, known as the Massachusetts standard type with No. 1 stone, is the one with which we are most familiar. It consists of a 2 in. to 3 in. top, or wearing surface, of No. 1 stone, bound with asphalt or tar. This top surface is usually laid on a broken stone base 4 in. to 5 in. in depth, which has been thoroughly rolled and bound up with dust or sand almost like a waterbound macadam road.

It is this last type of pavement which will be considered in this paper, treating it briefly under the following headings:

1. Materials used in the construction. (Stone and bitumen.)
2. Machinery and equipment necessary for proper construction. (Roller, kettles, asphalt wagon and motor distributor.)
3. Inspection of work in field.
4. Method of carrying on the work.

Materials.—The materials necessary for the construction of a good bituminous macadam road are first a good hard and tough stone, and second, a good grade of bituminous material, either asphalt or tar of the proper consistency. The stone should preferably be a good commercial trap rock or a local stone of its equivalent, having a French coefficient of wear of not less than 12 and a toughness of not less than 8. It should be available in No. 1 sizes, that is from 1¼ in. to 2½ in. or 2¾ in. The bituminous material may be any one of three kinds which shall have certain prescribed properties and among other requirements must meet the following:

(a) Fluxed native lake asphalt shall have a peneration of 120 to 150.

(b) Oil asphalts shall have a penetration of 90 to 120.

(c) Tars shall have a consistency of 120 to 180 by the float test.

Penetration at 25° C. (77° F.) 100 G., 5 Sec.

Machinery and Equipment.—The amount of machinery and equipment necessary for this work is probably smaller than for any other type of modern pavement. For that reason it is popular in cities and towns where they do not care to own ex pensive machinery. Provided th stone is trucked to the job and th bituminous material sent out from heating plant in a motor-sprayer about the only machinery needed o the job is the steam roller.

In case the work is to be done at considerable distance from any com mercial quarry, and too far to sen bituminous material by truck, then stone crusher would be needed, kettle in which to heat the bituminous ma terial, and a spraying wagon for ap plying it. It has been my experienc that with a trained organization, jus as good and perhaps better work ca be done with the wagon distributo hitched behind a roller as with th motor-sprayer. I should add, how ever, that today where work is bein done within trucking distance of bituminous heating plant, it is cheape and it facilitates the work if th motor-sprayer is used.

Inspection.—The inspection in th field is the most important phase o the work, and it is my opinion tha more penetration roads fail because o poor workmanship and poor inspec tion, than from any other cause. A bituminous macadam road may fai from poor design, because founda tions were omitted where they were needed, or the road built too thin, o it may fail because of poor quality o too little bituminous material, but I believe that more failures are due t other reasons and that the majority of them could be prevented if the in spectors were properly trained in the details of the work. My advice to any man who wants to make a success o this kind of work is to leave off the white collar and good clothes. The work is dirty, and no man can see what is going on unless he is willing to so dress that he can get into the midst of it.

Method of Construction.—The first step in the construction of the penetration road is the provision for adequate drainage. In loamy or clayey soils a subgrade of gravel 12 in. deep should be laid or a stone base on top of about 4 in. of gravel. In wet and springy ground, side drains should be built with broken stone and open-jointed sewer pipe, or ditches should be provided along the sides of the road in order to keep the ground water out of the subgrade.

Having drained the road and provided suitable subgrade, the next step

is to roll the subgrade thoroughly with a steam roller until no settlement can be discerned.

Base Course.—Upon this compact subgrade there is then spread a layer of broken stone, preferably No. 1 stone, but if it is necessary to use the output of a crusher, then the No. 1 and No. 2 stone may be mixed, being careful that they are mixed uniformly and that there is not an excess of the No. 2 size. This layer should be carefully spread, either from dumping boards or from self-spreading trucks, and after rolling should have a perfect cross-section 2 to 2½ in. below the desired finished surface. If depressions or bumps are visible, they should be carefully patched or removed, for the more perfect the base is made, the easier it is to get a perfect top surface. The usual thickness of the base course is 4 in., but where travel is very heavy, 5 or 6 in. may be used. After the base course has been bound up with the binder and rolled until it is thoroughly compacted, it should resemble somewhat a water-bound macadam surface, except it is not bound up so tightly. The surplus binder is then broomed from the surface and the top or wearing course can be spread.

Top Course.—The best results will be obtained in the top course if No. 1 trap rock is used, being careful that there is no No. 2 or finer stone mixed with it. This trap rock should be spread from a dumping board with forks and the dust, dirt and small stone left on the board thrown to one side and wasted. This is important, for with almost every truckload of broken stone there is a bushel or more of dirt and small stones, and if this is left in the road in one spot, as is likely, the proper penetration will not be obtained when the bitumen is applied, as the voids will be partly filled with dirt. Furthermore there would be a blot or "fat place" on the surface where the bitumen could not penetrate.

Having spread the top stone carefully from dumping boards and having done all the patching that can be seen at the time, the top surface should be lightly and carefully rolled and the patching continued until the road surface looks absolutely perfect. The patching should be done with No. 1 stone only, and it is important to do it before the surface is rolled too much, as it is very hard to roll a patch into a well rolled road. The top course is usually 2 in. thick, but I prefer about 2½ in. with 2½ gal. of asphalt per square yard. When the stone is so rolled that the roller does not make a track on the stone, but before the stone begins to break up under the roller, the top course is ready for the bituminous material.

The Penetration.—The engineer in charge of the bituminous work should now carefully inspect every square foot of the surface where he intends to apply the asphalt, to see that there are no depressions and that the stone is clean and of proper depth. Special care should be taken to see that the edges of the road are straight and neat, and that dirt from the shoulders has not been allowed to enter the top stone, for if the edges are neglected they will be the first to ravel. He should then see that the bituminous material is of the proper temperature and that all the nozzles of the sprayer are absolutely clean.

Having looked after the details, word may be given to go ahead and apply the bitumen. If asphalt is used it should be heated to a temperature of about 350° and applied under a pressure of 60 lbs. per square inch, at a rate of 1¾ gal. per square yard, either with a motor-distributor or with a wagon-sprayer, but not with a single nozzle. If the distributor streaks and does not apply the asphalt uniformly, it should be stopped at once and either removed from the top stone while the nozzles are being cleaned, or a trough should be put under the nozzles while they are driping and being cleaned.

When the load is being applied, one or two men should walk along on either side of the sprayer, and whenever a puddle or fat spot is seen, a pick or light-pointed bar should immediately be used to open up the stone and if possible let the asphalt down into the stone to prevent the puddle. If this is not done in a few seconds after the asphalt is sprayed, the asphalt will have set up and then the only way to correct the defect will be to cut out the top stone, replace it with clean stone, re-roll and penetrate again.

After the load has been distributed on the road, and before the asphalt is covered with pea stone, the engineer should carefully examine the surface to make sure that there are no white streaks or spots that have been missed. If any are found they should

be carefully patched with a pouring can.

Having examined the surface and found it O. K., pea stone should at once be uniformly and lightly thrown upon the asphalt while it is still hot, and the surface should be rolled. The application of pea stone should be so light that the roller at all times will be bearing on the No. 1 stone and not on a cushion of pea stone. If the wheels of the roller stick to the asphalt, as they probably will in warm weather, they should be oiled. More pea stone should be added as the rolling takes place, until the surface has an even texture with the voids mostly filled, but with no loose or surplus pea stone on the surface.

In spreading the pea stone, care should be taken to keep back about 12 in. from the edge of the spray along the middle of the road, so that there will be less chance of getting a puddle along the point due to overlapping when the second half of the road is sprayed.

Having covered the first application of asphalt with the proper amount of pea stone, and having thoroughly rolled the surface, then the surface should be swept clean of all surplus pea stone and the seal coat applied.

The Seal Coat.—The seal coat should be applied at a rate of not over ½ gal. per square yard. It is even more important than with the penetration work that the asphalt be hot and the nozzles clean, for the distributor is moving about four times as fast while applying the seal coat. Tar paper or building paper should be spread down on the road and covered with sand, at the point where the distributor is to be opened up, and the distributor should start far enough back from the point where it proposed to begin spraying so that it will have a flying start and be going at the proper speed when the nozzles are opened. After the load has been applied, the asphalt which landed on the paper is wrapped up and thrown to one side and if the work has been properly executed there will be a straight line joint where the seal coat started, without a surplus of asphalt on the portion already sealed.

If the work has been carefully done, the surface should not have a blot or fat spots in it, and I consider a blot a defect in the road. These fat spots may be caused by dirty stone, stone too small, or spread too thin or overlapping either at the center joint or at the beginning or end of a load, all of which can and should be avoided in order to get perfect results.

The seal coat is now covered with pea stone, using about the same method as outlined above for the penetration course, that is being careful not to put too much on at any one time, keeping it free from bunches and keeping the roller going while the seal coat is hot.

This final covering of pea stone should consist of just a little more than will stick to the road; it should be broomed about uniformly, and thoroughly and carefully rolled, this final rolling being very important, for there is then no danger of breaking up the No. 1 stone. A 12 to 15-ton roller is better than the 10-ton roller for this final work.

Not a single load of binder should be applied except when there is an inspector or engineer present. After applying both the penetration work and the seal coat, the bituminous material that overlaps on the shoulders should be trimmed off to the line of the edges of the broken stone, in order to get a good clean-looking line along the edges of the road.

I have been speaking, up to the present, of the asphalt penetration. However, asphalt and tar are both used in bituminous macadam roads, and the same methods for carrying on the work should be used with either material.

Bituminous Macadam for Resurfacing.—The bituminous macadam road has been used extensively and successfully to resurface the old water-bound macadam surfaces, and in this field it can be most economically used, for in many places the old macadam surface will furnish the necessary base for a new 2 in. wearing surface. When built in this way care should be taken to locate the spots that rut in the spring or break with frost, and they should be strengthened or subgraded.

Building in Half Sections.—The bituminous macadam construction is perhaps the easiest modern pavement to build one-half at a time when the road is kept open to travel. It can be built in 1,000-ft. sections—first on one side of the road and then leaving a distance of a few hundred feet for a turnout, building 1,000 ft. on

the other side of the road. With half a dozen flagmen, work can be under way on three 1,000-ft. sections at the same time, and just as soon as one section is finished it can be opened up to travel and the work shifted over to the other side.

I have looked after several miles of work where the road has been built one-half at a time, and have obtained results just as good as if the whole road had been built at the same time. It should be added that the width of construction was 20 ft. on some of this work. It is very difficult to get good results in building an 18-ft. road one-half at a time, on account of difficulties in rolling. It is true, however, that the work of the inspector is greatly increased and also the cost to the contractor, if the road is built one-half at a time.

I obtained some data as to the increased cost of building one side at a time and allowing traffic on the other side on the Boston and Worcester road, a portion of which was built in 1917 the full width at one time, and part in 1918 one-half at a time. This data showed that for the actual work that takes place *on the road, including* the flagmen and watchmen, the costs of excavation, spreading and rolling the bottom stone and spreading and rolling the top stone increased between 40 and 50 per cent. Of course the work that takes place *off the road* would not be affected, such as the breaking and crushing of stone or the initial cost of stone and asphalt. Considering the total cost of the entire pavement, built one-half at a time, the increased cost would be about 15 per cent.

Another item of importance is the season of the year in which penetration work should be done. I do not believe that perfect results can be obtained on work done after the middle of September. Work finished previous to July 1 or Aug. 1 is usually much better than work finished after Oct. 1. The reason for this is that work done in the early summer gets the benefit of being rolled during the hot weather, and the travel and sun help to bond the stone and the asphalt.

When work is done in the fall, it means spraying the bitumen into cold and perhaps damp stone. The stone may not look damp on top, but is very liable to be so beneath the surface. The hot bitumen cools off the minute it strikes the surface and consequently there is not good penetration. Then the roller goes over the surface and instead of the stone and asphalt becoming firmer under the rolling, the slight bond that exists is likely to break and the stones of the top surface are covered with asphalt but not thoroughly bonded together. Then a seal coat is put on, hoping to strengthen the bond, and it is undoubtedly strengthened on the surface, but the stones below are still not properly bonded. If travel could be kept off until the following summer, and the surface then thoroughly rolled, good results would probably be obtained but the road is generally thrown open to travel with weather conditions such that the road does not improve in the way that it does in the summer. Consequently, it is usually only a short time before raveling takes place, especially if there is snow, and ice ruts are formed. Under these conditions blame is often placed either on the asphalt or on the construction, when in fact, the chief blame is probably due to the weather conditions. If bituminous macadam must be built late in the fall, it should be kept well covered during the winter with a clean, coarse sand, in order to keep the travel off the road metal.

Maintenance of Bituminous Macadam.—There are on the State roads of Massachusetts today approximately 555 mi. of bituminous macadam surfaces, of which 35 mi. are of the old hot oil type and 520 mi. are of the modern types. The modern type may be further divided into two classes—asphalt penetration and tar penetration—there being about 260 mi. of each. This compares with a total of about 270 mi. for all other types of modern surfaces—such as bituminous concrete, cement concrete and block paving.

The amount and the type of maintenance and its cost on any particular bituminous macadam road will depend a great deal on the season of the year in which the road was built, and the results obtained in the construction. A surface without proper foundations, which is wavy, and has either too much or not enough bitumen, will obviously need much more attention and will cost more to maintain than a road properly designed and built with a perfect surface.

It is therefore difficult to outline any

one organization which could handle economically all kinds of maintenance. An ideal organization in one locality might not be the right size in another.

It is a well known fact that the maintenance on any road should begin the day the road is finished, and the foreman should always be alert for any weakness that may develop in the surface. "A stitch in time saves nine" applies as much to the surface of the road as it does elsewhere.

The winter maintenance of these roads should consist in keeping them covered with sand, if built late in the season, and in keeping the ice ruts sanded when they reach the road surface.

In the early spring when the road is damp and moist and cracks appear in the surface, it is usually due to moisture in the subgrade, and at that time the road should be kept covered with sand until the surface dries out.

Where patches must be made on a good surface, they should be of the same material as that of which the road was built. It is recommended that the hole be cut out square, going back far enough to insure a good joint. Then place No. 1 stone carefully in the hole, roll, patch and reroll until a straight-edge resting on the edges of the old surface will just touch the new stone. If the patch is a little low, do not assume that the pea stones will bring it up, for they will not. Paint the edges of the hole with hot asphalt or tar and spread sand around the hole to prevent the overlapping of the bitumen on the old surface. Pour in the hot bitumen, cover with pea stone lightly, broom and roll. Sealing can be done at this time, or later when "paint patching" is being done on the rest of the road.

This "paint patching" consists of painting the surface with hot bitumen and covering with pea stone. Much work and expense can be saved by its use where the surface shows signs of disintegration, for if left unpainted, holes will usually develop. Tar should be used for painting tar roads and asphalt on asphalt roads.

An ideal organization and equipment for this kind of work is a Ford truck, containing sand, pea stone, wood and tools, etc.—hauling a 50-gal. kettle. Add to this one man sweeping the road ahead, a second man applying bitumen with a broom or pouring pot, and a third man covering with pea stone or sand, tending the fire and doing miscellaneous work.

Care should be taken not to apply too much bitumen in cold weather or bunches will develop in warm weather. Where bunches do develop, they can be most easily removed with a wedge-pointed pick, kept very sharp.

Machine-mixed Patching Material.—During the spring of the year, when there is much patching to be done on some of the old penetration roads, we have found it advisable to set up a mixing plant at some central point, in order to turn out a cold patch mixture to repair all the roads as quickly as possible. In making these patches, care should be taken to use No. 1 or No. 2 stone in the deeper holes and chestnut stone or pea stone in the small holes. Where No. 1 stone is used in the deep holes, we have found it advisable to feather off with a pea stone mixture. Later we seal with either tar or asphalt to keep the water out and prevent disintegration.

I am in favor of machine-mixed cold patch material, as there is a saving of about one third in the amount of bitumen used, and the stone is more uniformly and thoroughly coated, and the cost is much less.

On every bituminous macadam road there probably comes a time when a maintenance seal coat is desirable. On tar roads this time will probably come during the second or third year, and I recommend using an asphalt seal coat, providing the tar surface is in such shape that it will take the asphalt. If the asphalt cannot be applied successfully, I would then prefer a tar of the consistency of Tarvia A. However, if the road has been previously treated with cold tar, it is doubtful whether either of the above seals could be applied successfully. In that case probably a cold tar should be used.

The asphalt roads will last for a much longer time without this maintenance seal coat. A well-built asphalt penetration surface should go at least six years. In Weston, where a native asphalt was used, there has been no maintenance seal coat in ten years, and in Dracut, where five different kinds of oil asphalts were used in 1913, the surface is still unsealed except for the seal coat applied when the road was built.

Data on Experimental Bituminous Macadam.—In concluding this paper,

I shall give some statistical data obtained from a piece of experimental bituminous macadam construction, built by the State in 1913, on which the writer was the resident engineer.

This road, which is in Dracut, between the cities of Lowell and Lawrence, is 3¼ mi. in length. It was subgraded with from 6 to 12 in. of gravel, and the wearing surface, 2 in. thick, was built on top of a 4 in. macadam base with a good grade of local stone, part of which resembled a commercial trap.

Six sections, approximately ½ mi. in length, were built of asphalt, using five different kinds of oil asphalt and one native asphalt, making a total of three miles of asphalt macadam. The remainder, about ¼ of a mile, was penetrated and sealed with tar.

This road has now been under maintenance nine years. At no time has the writer had any part in this maintenance or in the keeping of the costs. From the maintenance engineer in charge of this road I obtained the information that no money was spent on the surface of this entire road last year, and also that the average cost per mile per year for the asphalt portion was less than $28. The tar portion was higher, on account of having been sealed, but because there was only ¼ mi. of it, it does not seem fair to compare it with the asphalt.

Among other well-constructed bituminous macadam asphalt roads, where the maintenance costs have been very low, the following may be mentioned:

(1) Weston, 3 mi. in length, built in 1912 and 1913, without foundations, where the cost has run $90 per mile per year.

(2) Concord, built in 1918 and 1919, 3½ mi. in length, where the cost has run $62 per year for the first piece built in the fall of the year, and $40 per mile per year for the second piece built in the summer.

(3) Lexington, from East Lexington to Lincoln, 3.4 mi. in length, built in 1918, where the cost has been $26 per mile per year.

(4) Sudbury and Lincoln, 2½ mi. and 2 mi. respectively in length, built in 1916, where costs have run $52 per mile per year and $37 per mile per year.

Repaving Midan Soliman Pasha Square at Cairo, Egypt, With Trinidad Lake Asphalt.

View shows two Iroquois 8-ton rollers at work. It also offers an interesting contrast in ancient and modern means of transportation. Three autombiles will be noticed in the street back of the statue, while at the right is a camel bearing a pack and on the left is an Egyptian donkey cart. Both the asphalt and the roller were sold by the Barber Asphalt Co., and the work is being carried on by an American engineer, D. Basil W. Alexander.

Determination of the Area of Assessment

Method of Fixing Areas of Assessment for Benefit in Park and Street Opening Proceedings Described in Report of Chief Engineer Board of Estimate and Apportionment, New York City

By BERTHOLD SCHEIMAN,
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The annual report of this office for 1917 contained the results of studies theretofore made to determine a consistent method of fixing areas of assessment for benefit in park and street opening proceedings in which the benefit extends a considerable distance from the improvement. These studies led to the deduction of a formula by means of which the extent of an area required to equitably bear the whole or part of the cost of improvements of this character could be readily determined. The application of this formula since its adoption in 1917 has indicated the desirability of calling attention to certain practical considerations that should be observed in its use, and at the same time present a simpler yet more complete demonstration of its development.

The Basis of the Formula.—The basis of the formula was a curve showing the diminishing rates of assessment as the distance from the improvement increases. This curve was deduced from an analysis of the distribution of assessments adopted in a large number of park proceedings carried out by the City of New York at various times during a period of almost 100 years, and also from an analysis of a rule for apportioning assessments in street opening proceedings involving district benefit which had become well established through its sanction by the courts.

The curve of diminishing assessments was represented by a formula which fixed the relation between assessments on consecutive areas 100x 100 ft., located along streets leading directly to the improvement, which relation, beginning with the first or frontage area, is as follows:

55, 19.16, 14.16, 11.68, etc.

In terms of the assessment on the first area, this relation becomes 1.0, 0.35, 0.26, 0.21, etc.

How the Size of Area Is Found.—From this relationship the extent of the area required to equitably meet the whole or any part of the cost of acquiring a park or street by assessment may be found as follows, using the same nomenclature as that adopted in the 1917 report:

Let A = Area of frontage zone, expressed in units of the same value as used in fixing the assessment rate.

a = Increment in area of successive zones of equal depth, expressed in units of the same value as used in fixing the assessment rate.

n = Number of zones of equal depth in the entire assessment district.

S = Total amount to be assessed.

r_1 = Assessment on a unit of area in the first zone.

r_2 = Assessment on a unit of area in the second zone.

r_3 = Assessment on a unit of area in the third zone.

r_n = Assessment on a unit of area in the nth zone.

Then $S = Ar_1 + (A+a)r_2 + (A+2a)r_3 + (A+3a)r_4 \ldots + [A+(n-1)a]r_n = A(r_1+r_2+r_3+r_4 \ldots + r_n) + a[r_2 + 2r_3 + 3r_4 \ldots + (n-1)r_n]$ (1)

The value of the expression $(r_1 + r_2 + r_3 + r_4 \ldots + r_n)$ is the sum of the respective unit assessments for each of the zones in the entire assessment district. This sum in terms of the assessment rate on the first zone is $(1.0 + 0.35 + 0.26 + 0.21 \ldots + \text{etc.})r_1$, and may be expressed by the formula

$$y = n^{0.43}\, r_1 \qquad (2)$$

in which y = the sum of the unit assessments in terms of the assessment on the first zone, and n = the number of zones.

The first term of equation (1) is therefore equal to $An^{0.43}r_1$. From equation (2) the assessment rate for any zone in terms of that on the first zone will then be equal to $[n^{0.43} - (n-1)^{0.43}]r_1$. The value of any quantity $(n-1)\ r_n$ in the second term of equation (1) would therefore be $(n-1)\ (n^{0.43} - (n-1)^{0.43})r_1$ which reduces to $[n^{1.43} - n^{0.43} - (n-1)^{1.43}]r_1$.

The second term of equation (1) for any number of zones, then becomes:

$$a\,(2^{1.43} - 2^{0.43} - 1^{1.43})\, r_1$$
$$+ a\,(3^{1.43} - 3^{0.43} - 2^{1.43})\, r_1$$

$+a\,(4^{1.43}-4^{0.43}-3^{1.43})\,r_1$
$+a\,(n^{1.43}-n^{0.43}-(n-1)^{0.43})\,r_1$
which reduces to what may be expressed as $a\,(n^{1.43}-\sum_1 n^{0.43})\,r_1$ and

$$S=[An^{0.43}+a\,(n^{1.43}-\sum_1 n^{0.43})]\,r_1. \qquad (3)$$

The values of the quantities $n^{0.43}$ and $(n^{1.43}-\sum_1 n^{0.43})$ to 50 zones are given in the following tables:

Value of $n^{.043}$ to 50 zones.

No. of Zones	Value	No. of Zones	Value
1	1.000	14	3.111
2	1.347	15	3.204
3	1.604	16	3.294
4	1.815	17	3.381
5	1.998	18	3.466
6	2.161	19	3.547
7	2.309	20	3.626
8	2.445	21	3.703
9	2.572	22	3.778
10	2.691	23	3.851
11	2.804	24	3.922
12	2.911	25	3.991
13	3.013		

No. of Zones	Value	No. of Zones	Value
26	4.059	38	4.779
27	4.126	39	4.832
28	4.181	40	4.885
29	4.254	41	4.937
30	4.317	42	4.988
31	4.378	43	5.040
32	4.438	44	5.090
33	4.497	45	5.139
34	4.556	46	5.188
35	4.613	47	5.236
36	4.669	48	5.284
37	4.724	49	5.331
		50	5.377

Value of $(n^{1.43}-\sum_1 n^{0.43})$ to 50 zones

No. of Zones	Value	No. of Zones	Value
2	0.347	14	11.77
3	0.860	15	13.07
4	1.494	16	14.43
5	2.225	17	15.82
6	3.04	18	17.25
7	3.93	19	18.72
8	4.88	20	20.22
9	5.90	21	21.76
10	6.98	22	23.33
11	8.10	23	24.94
12	9.27	24	26.57
13	10.50	25	28.24

No. of Zones	Value	No. of Zones	Value
26	29.8	38	52.4
27	31.7	39	54.5
28	33.4	40	56.5
29	35.2	41	58.6
30	37.0	42	60.7
31	38.8	43	62.8
32	40.7	44	65.0
33	42.6	45	67.2
34	44.6	46	69.3
35	46.4	47	71.6
36	48.4	48	73.8
37	50.4	49	76.1
		50	78.4

Corrections for Amount Assessed.—Since, in developing the formula, it was assumed that the entire area embraced within an assessment district was assessable, and that the areas comprised within each zone are assessable at a uniform rate, it becomes necessary to make two corrections to the value of S found by formula (3) in order to fit actual conditions.

The unassessable portion of an assessment district is assumed to comprise only the area within the streets. Where a complete street system exists, the ratio of the street area to the total area can be readily estimated with sufficient accuracy from the general average of the block dimensions and street widths, but where a complete street system is lacking, the existence of one must be assumed in order to conform to the conditions under which the formula was developed.

The adjustment required to allow for the unequal assessment rates applicable to the areas comprising each zone by reason of their varying distances from the improvement, as measured along the street lines, has been found as follows:

Under the prevailing rectangular street system the zones would naturally be rectangular in form, but this usually makes it necessary, especially in districts of great size, to exclude areas at the corners in order to keep the perimeter at an approximately uniform distance from the improvement. To meet this condition, the zones are assumed to have a form such that the value of "a," or the constant increase in their area, for zones having the depth of a standard city lot, or 100 feet, would be 40,000 sq. ft., instead of 80,000 sq. ft., as would be the case for rectangular zones.

Consider a territory wholly divided into 100-ft. squares and traversed by two systems of parallel lines at right angles to each other, the lines being in the one case 800 ft., and in the other 200 ft., apart, and forming a rectangular street plan with blocks each 200 by 800 ft. Also assume that one of the blocks described is selected as a park site. It will be found that the sum of the products of the number of squares within any number of zones of the form assumed, and the assessment rates applicable to them as found from their shortest distance from the park measured along the assumed street lines, will bear to the sum of the products of the same num-

ber of squares and their theoretical assessment rates the following relations:

No. of Zones	Per Cent.	No. of Zones	Per Cent.
1	100.0	10	93.2
2	84.3	15	94.3
3	92.9	20	95.2
4	92.3	25	95.8
5	92.3	30	96.5
6	92.3	35	96.8
7	92.5	40	97.1
8	92.7	45	97.4
9	92.9	50	97.6

Effect of Approaches to Park on Assessment.—It may be readily shown that the greater the number of avenues of approach to the park, the more closely will the actual assessment upon any number of zones approximate the theoretical assessment. It will also be apparent that an extension of the park in a direction of the short block lengths would, under the assumed street plan, decrease the discrepancy between the actual and theoretical assessment, while a longitudinal extension would increase this discrepancy. The maximum difference would, however, be found where the length of the park was so great as to render the influence of the areas adjoining the short sides of the park and at the corners negligible, which condition would be satisfied by assuming the assessment area to be confined wholly to the territory adjoining the long sides of the park, in which case the zones would be equal in area and the value of "a" would become zero.

A computation similar to the one already described of the relations between the actual and theoretical assessments under the latter condition showed the following:

No. of Zones	Per Cent.	No. of Zones	Per Cent.
1	100.0	10	87.8
2	91.0	15	88.6
3	89.1	20	89.3
4	87.8	25	89.9
5	87.7	30	90.3
6	87.4	35	90.7
7	87.5	40	91.1
8	87.5	45	91.5
9	87.7	50	91.7

This condition is the one common to assessment areas for streets, especially where the street is very long or where the assessment district is not extended beyond its terminals.

If consideration be given to the assumed absence of all diagonal streets and to the fact that contiguity to the improvement, particularly for areas within the nearest zones, somewhat offsets the effect of their actual distance measured along the street lines, it would seem from an inspection of the two sets of relationship found from the hypothetical case described that the second correction might properly be made by applying a coefficient of from 0.9 to unity to the value of S as found from formula (3).

Assuming that one-third of the area of a territory falls within the street lines, then equation (3) for any street or park, whether a complete street system exists or not, may conservatively be stated as:

$$S = 0.6r_1 \left[An^{0.43} + 40{,}000 \left(n^{1.43} - \sum_1 n^{0.43}\right)\right]$$

For very long streets, or those for which the assessment area does not extend beyond the terminals, the total assessment may similarly be found from the following:

$$S = 0.6r_1 An^{0.43}$$

It should be noted that in those cases where the existence of a complete street system is assumed, the assessments will be predicated upon a future rather than a present relation of the property assessed to the improvement.

The Frontage Assessment.—Of fundamental importance in the application of the formulae, is the assessment rate which should be applied to the frontage. The analysis presented in the 1917 report showed that there appeared to be ample justification for fixing the frontage assessment for all parks at 10 per cent of the frontage land value. Owing, however, to the great variation frequently found in the value of lands abutting a proposed park site, this method of fixing the frontage assessment rate has not always proved satisfactory.

While in general, the frontage assessment in the case of parks might reasonably be fixed at 10 per cent of the frontage land values, experience has indicated that the practical course to pursue in determining this matter would be to fix the frontage rate only after a careful consideration of all the features peculiar to each individual case. After this is done, the extent of the area required to bear the whole or any desired part of the cost of the project will be determined by applying the related formula, or, conversely, the amount which can be raised on any given assessment district. It would also seem best for all the interests concerned to express the frontage rates in terms of money, with the understanding that the actual assess-

ment will bear the same relation to the amount thus assumed as the actual cost of the project bears to the estimated cost.

An important point that should be observed in the apportionment of assessments over areas of general or neighborhood benefit is the avoidance of the sudden drop from a substantial rate to zero at the boundary. This condition is generally satisfied under the assessment areas fixed in accordance with the adopted scheme, but in cases where the assessment area must be restricted it may be necessary in observing this condition and still maintain the assumed relation between the assessments, to decrease the frontage rate and meet the resulting deficiency by a borough or city charge, or to assume that a different gradation of assessments will be applied.

In those cases where the benefited property is largely acreage the practice has been to fix a minimum average assessment rate of $5 or $10 per acre, which rate, it was assumed, would be applied uniformly to the territory beyond the zone for which this rate is fixed under the adopted assessment curve. In developed territory a similar condition is assumed for areas beyond the zone in which the average assessments, if graded in accordance with the adopted curve, would reach a minimum of $5 per city lot.

Study Being Made of Street Lighting System

The U. S. Bureau of Standards, Washington, D. C., is making a study of the various systems of street lighting used in cities and towns throughout the country. This work is now well under way and is receiving the hearty co-operation of municipalities and operating utilities. Several hundred replies to questionnaires on engineering practice and contract requirements have been received and are being carefully analyzed. Very full engineering data have been furnished by thirty or more of the larger operating companies on the basis of which a survey of the best practice is being prepared as a part of a comprehensive report on street lighting service.

Status of Federal Aid Highway Construction on July 31, 1923.

STATES	FEDERAL FUNDS							TOTAL COST AND MILEAGE OF PROJECTS COMPLETED FROM JULY 11, 1916 TO July 31, 1923	
	APPORTIONMENT BALANCE JULY 1, 1923	ALLOTTED OR PAID FOR SPECIFIC PROJECTS					BALANCE FOR NEW WORK (DEDUCT COLUMN 6 FROM COLUMN 1)	FINAL COST	MILEAGE
		ALLOTTED TO PROJECTS NOT YET UNDER CONSTRUCTION	PROJECTS UNDER CONSTRUCTION: TO BE PAID AS CONSTRUCTION IS COMPLETED	PROJECTS UNDER CONSTRUCTION: PAID FOR COMPLETED WORK	PAID ON PROJECTS COMPLETED SINCE JULY 1, 1923	TOTAL ALLOTTED OR PAID (SUM OF COLUMNS 2, 3, 4 AND 5)			
	1	2	3	4	5	6	7	8	9
ALABAMA	$ 7,916,207.23	$ 1,626,346.56	$ 3,306,160.71	$ 1,730,975.49	$ 26,436.25	$ 6,693,920.21	$ 1,152,287.22	$ 3,846,791.52	370.8
ARIZONA	3,247,705.78	756,334.05	556,110.00	1,218,275.75	48,785.47	2,579,109.31	1,068,596.45	6,600,901.41	376.7
ARKANSAS	4,434,970.81	515,772.77	1,182,350.31	1,147,565.52	116,149.22	2,961,466.72	1,513,504.09	6,910,655.52	730.6
CALIFORNIA	11,089,347.32	1,135,150.46	2,626,626.41	3,394,491.16	205,347.53	7,164,157.58	3,925,189.74	9,043,793.68	376.6
COLORADO	5,062,160.27	1,772,188.63	1,029,263.79	841,997.69	63,608.94	3,523,267.05	1,538,893.22	6,575,618.18	429.3
CONNECTICUT	1,879,532.24	646,104.56	700,773.95	175,751.55		1,130,130.06	749,396.18	2,568,641.35	60.7
DELAWARE	752,750.00	419,750.00	117,900.26	200,648.22		738,598.50	152.50	2,196,610.22	45.3
FLORIDA	5,369,849.85	1,753,943.60	1,115,344.77	2,009,905.04		5,149,194.61	220,655.24	69,466.31	15.6
GEORGIA	6,103,170.41	1,415,249.56	1,946,726.36	1,851,659.69		5,213,631.61	889,538.80	11,960,499.47	925.5
IDAHO	2,468,102.98	77,790.26	467,580.70	589,225.16		1,114,595.54	1,354,377.44	6,880,673.73	476.1
ILLINOIS	8,818,332.05	3,007,771.67	2,415,146.25	747,506.67	16,826.90	6,227,275.44	2,591,056.61	25,745,184.04	744.7
INDIANA	8,784,011.13	2,625,481.14	3,324,844.24	1,700,614.99		7,652,940.67	2,271,054.46	5,613,487.78	157.0
IOWA	7,801,752.15	652,204.30	2,708,745.50	2,517,149.39		5,877,638.69	1,924,113.70	15,040,379.62	1059.4
KANSAS	8,969,620.62	381,486.39	1,468,116.11	2,334,326.72	44,729.50	4,660,162.51	4,309,458.11	12,412,562.64	152.7
KENTUCKY	6,170,153.46	1,561,378.87	1,741,487.75	1,651,295.41	40,996.36	6,016,160.39	1,054,063.21	6,718,086.84	268.0
LOUISIANA	3,113,012.38	743,314.35	1,302,2[illegible]4.15	503,423.40	200,000.00	2,748,986.90	164,025.48	7,829,936.05	672.8
MAINE	2,180,535.61	666,676.37	736,313.28	597,650.94		2,002,641.79	177,893.82	4,602,654.19	159.9
MARYLAND	1,488,161.45	466,951.50	1,224,231.[illegible]	778,931.92	32,406.26	3,467,421.37	20,739.48	5,374,237.46	187.1
MASSACHUSETTS	4,827,615.39	1,139,414.69	1,263,711.65	632,293.75	76,359.91	3,065,114.50	1,762,500.89	7,061,122.40	187.2
MICHIGAN	9,309,130.13	3,526,716.40	3,335,214.62	1,594,613.60		8,456,564.52	852,565.61	3,628,041.53	363.4
MINNESOTA	5,193,834.57	916,600.20	1,810,833.09	1,615,165.27	82,975.79	4,425,574.15	1,087,660.42	18,257,183.81	1217.6
MISSISSIPPI	5,952,343.43	1,092,575.46	1,836,[illegible]33.13	1,544,760.20	31,735.32	5,644,466.40	307,877.03	4,915,566.37	466.1
MISSOURI	13,137,853.65	1,537,126.60	6,707,446.46	2,718,313.52	87,387.65	10,050,486.12	3,187,365.53	5,447,800.71	384.0
MONTANA	5,525,880.31	9,530,054.57	104,306.52	581,523.38	5,581.27	3,262,476.29	2,263,404.22	7,947,612.18	711.5
NEBRASKA	8,424,115.60	214,635.73	1,106,970.70	3,096,9[illegible].38	47,602.12	4,607,380.19	3,824,735.43	3,263,735.37	496.0
NEVADA	4,580,586.48	1,692,290.86	1,033,267.07	861,106.15	80,900.14	4,167,764.22	196,800.21	3,158,586.17	212.6
NEW HAMPSHIRE	940,234.30	772,328.57	250,818.42	136,534.02		1,159,677.21	201,237.29	2,336,297.00	140.6
NEW JERSEY	3,677,050.48	1,62[illegible],729.43	315,613.54	447,656.46		2,830,923.40	1,046,847.08	5,433,183.96	112.1
NEW MEXICO	4,870,139.44	1,763,261.12	1,152,654.20	780,605.65	71,199.79	3,768,720.75	1,101,418.69	6,606,785.46	555.4
NEW YORK	18,604,352.44	3,[illegible]46,133.30	6,125,409.26	3,107,476.74	100,580.58	13,213,145.68	5,467,236.56	10,027,675.01	297.8
NORTH CAROLINA	5,271,241.47	647,313.16	1,677,815.45	908,[illegible].50		3,634,816.31	1,636,505.16	11,770,163.76	676.6
NORTH DAKOTA	4,892,348.78	127,[illegible],04	1,101,045.73	1,102,150.76	26,214.42	2,757,275.92	1,925,122.86	5,197,425.33	616.0
OHIO	9,378,834.14	1,323,605.00	2,930,408.02	2,520,871.69	130,149.75	6,875,[illegible].56	2,503,268.58	22,242,250.32	221.2
OKLAHOMA	6,343,724.83	2,790,609.15	1,162,[illegible].42	1,250,[illegible].65	48,081.07	5,251,100.29	1,114,221.54	9,891,756.69	381.5
OREGON	2,544,538.47	582,160.40	1,173,[illegible].03	780,360.12		2,416,639.55	129,758.92	10,391,162.48	534.1
PENNSYLVANIA	8,620,601.09	80,286.27	1,377,450.24	2,611,714.86		4,069,631.25	4,779,229.74	33,380,229.45	652.8
RHODE ISLAND	919,781.17	141,212.50	415,266.13	555,426.63		1,111,905.26	383,119.54	1,484,015.15	38.6
SOUTH CAROLINA	3,747,763.42	794,361.12	1,029,465.66	1,210,718.62	60,943.34	3,104,788.94	642,974.48	6,146,631.69	631.7
SOUTH DAKOTA	3,189,528.43	410,512.66	1,272,698.74	1,318,425.78	129,128.94	3,131,541.04	1,057,987.40	5,021,798.66	567.4
TENNESSEE	6,969,133.86	571,693.66	3,557,439.46	3,140,726.56		7,471,861.66	1,388,272.19	3,210,872.94	112.5
TEXAS	16,213,973.47	4,900,932.19	3,719,666.66	4,272,949.76	831,673.36	12,705,413.97	3,514,553.50	10,608,485.41	2357.2
UTAH	6,072,730.42	730,773.64	929,474.67	1,135,577.12	141,270.61	2,935,356.04	3,116,337.18	2,345,213.65	121.3
VERMONT	1,458,919.98	216,850.75	535,147.33	198,925.94		750,924.02	745,995.96	1,100,715.63	53.1
VIRGINIA	5,865,368.89	1,086,046.54	2,574,152.97	1,601,685.90		5,162,064.67	703,276.29	6,623,976.16	409.5
WASHINGTON	1,954,154.13	360,320.00	660,634.33	180,026.87	1,000.36	1,201,420.00	752,734.13	10,439,247.33	629.0
WEST VIRGINIA	3,154,984.12	587,245.50	957,658.52	1,240,378.01	14,946.29	3,540,216.31	611,669.11	4,345,934.16	614.4
WISCONSIN	5,893,951.64	1,124,857.23	3,189,906.71	448,613.67		4,763,377.61	2,989,481.63	15,504,631.39	1077.8
WYOMING	3,934,194.67	933,686.12	1,359,761.61	804,338.09		3,133,786.41	800,918.26	1,611,533.36	324.7
TOTALS	$ 277,886,389.18	$ 60,291,638.60	$ 91,945,715.58	$ 65,423,146.11	$ 2,580,440.89	$ 219,240,960.80	$ 67,714,346.38	$ 416,090,064.56	23792.5

* AMOUNTS PAID ON PROJECTS COMPLETED PRIOR TO JULY 1, 1923 DEDUCTED

The Illumination of City Streets and Highways

Methods of Street Lighting for Residential and Business Districts Discussed in a Paper Presented at Last Annual Convention of Illinois Society of Engineers

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The question of lighting city streets is one that has always commanded interest because of the intimate connection between illumination and safety and convenience. The methods used have been changing constantly. During our own lives we have seen used successively gasoline lamps, gas lamps, various forms of electric arc lamps, and lastly, incandescent electric lamps. Today the incandescent lamp is replacing the other methods, therefore only lighting by incandescent lamps will be discussed in this paper.

Rapid Development of Lighting Units.—At no time has any one of the various methods commanded the field long enough to establish itself as the standard method. This has been due partly to the rapid development of lighting units, a development which is progressing as energetically now as at any earlier time, as well as to the constantly changing conception of what is desirable.

Until a few years ago comparatively no attention was paid to the esthetic side of street lighting, the idea simply being to have more or less illumination supplied. At present, the matter of general appearance is given practically the same weight as the degree of illumination, and the units to be used are selected as much for their effect upon the appearance of the street as for their efficiency and light distribution.

In the lighting of streets, pedestrian and vehicular traffic must be considered. The ideal condition for pedestrian travel is illumination that is not necessarily intense but which is uniform. This condition of uniformity is not so important for vehicular traffic, as will be pointed out later. Uniformity of illumination demands lighting units located at short intervals, a requirement that is met naturally by an ornamental system.

Classification of Streets for Illumination Purposes.—Streets can be divided into four distinct classes: (1) residence streets, the traffic on which is due mainly to the residents on the street itself; (2) residence streets handling considerable through traffic; (3) semi-business streets, those on which retail stores and residences are intermingled or streets given over to wholesale and storage houses or factories; and (4) main retail streets. On the streets of all but the first class other factors than those mentioned will enter. For instance, it is a recognized fact that high intensity of illumination has a decidedly stimulating effect and for this reason the main retail districts should have an illumination greatly in excess of the actual needs for safe travel.

Intensity of Illumination.—Intensity of illumination is spoken of in terms of foot candles. A foot candle is the intensity of illumination on a surface 1 ft. from a source of one candle power, or 2 ft. from a source of four candle power, etc. The following minimum intensities of illumination represent present practice fairly well: Purely residential streets, 0.02 foot candle (this is about equal to bright moonlight); boulevards or through streets and semi-business streets, 0.04 to 0.05 foot candles; main retail streets, 0.1 or more foot candles. To determine the size and spacing to produce the above degrees of illumination, it is necessary to know the distribution of light given by the lamp. The shape of the distribution curve can be controlled by the shape of the surrounding globe, or by reflectors or by both together.

Comparison of Three Tops. — A comparison will be made of three styles of tops, a ball globe, a top shaped to produce more downward light and a top using a prismatic refractor. A minimum illumination of 0.02 foot candles can be obtained with the lamps of 100 c. p. alternating on the two sides of the street and with spacings as follows, measured along the street: Ball globe, 90 ft; shaped globe, 100 ft.; shaped globe and refracting dome, 117 ft. The comparative cost per 100 ft. of street for the standards and foundations is

$672, $655 and $605, respectively. The saving in first cost shown by the second and third types is in a measure offset by the greater cost of glassware for replacing broken tops and this factor may, in some cases, lead to the selection of the first type. Where higher intensity is desired it can be obtained by using larger lamps or by placing the standards opposite each other or by both together.

Power can be supplied to the lamps either by means of a constant-voltage or a constant-current system. In the constant-voltage system (often called the multiple system) two wires are carried along the streets and 110 or 220 volt lamps are connected between them. The current to be supplied is the sum of the currents taken by the individual lamps and while the current taken by each lamp is small, the total may be quite large. The filaments in the lamps are long and of small diameter. This system is not satisfactory because the large current necessitates the use of large wire and also because the lamps do not withstand the vibration due to traffic well.

In the constant-current or series system the lamps are all connected in series, the same current flowing through all the lamps. This current can be made larger than that taken by a single multiple lamp but at the same time being much smaller than the total current in that system. If the current through a lamp is increased the voltage across it is decreased to keep the candle power the same. The total voltage of this system is the sum of the voltages of the individual lamps and may be built up to several thousand volts. The filament of the series lamp is shorter and larger than that of the multiple lamp and therefore it withstands vibrations better. For these reasons the series system is widely used and it is the system that will be discussed here.

The Types of Series Systems.—There are three types of series systems for supplying power to the lamps—straight series, straight series with current transformers at each standard, and the group system. In the straight series system, all of the lamps supplied by one regulator are connected in series across the regulator. If the district to be lighted is some distance from the control station, it is desirable to have as many lights as possible on one regulator to reduce the cost of cable from the station to the district. This results in the use of high voltage, which is undesirable for two reasons—(1) liability of injury to persons coming in contact with any part of the system; and (2) the high cost of cable suitable for such high voltage. On the other hand, this system has the advantage of simplicity, the equipment being reduced to a minimum.

In the series system with individual current transformers, an individual current transformer is installed in the base of each standard, thus insulating the lamp and leads up to the standard, from the high voltage carried on the underground cables. This system has the following advantages: (1) the life hazard present in the straight series system is eliminated; (2) if high power lamps are used the current transformers can be used to supply the large current required by the lamps while a smaller current is used in the line, thus reducing the cost of line copper required. When use is to be made of the small sized lamps, this advantage disappears. The disadvantages of this system are: (1) high initial cost; (2) increased number of sources of trouble due to the increase in the amount of equipment needed.

In the group system the lamps are divided into groups and one insulating transformer is used for each group. The advantages are: (1) the voltage of each group can be kept low enough to practically eliminate the life hazard present in the straight series system, nearly equalling in this respect the individual transformer system; (2) since the voltage for the entire group is lowered, a cheaper cable can be used than is required for either of the other systems. The disadvantages are: (1) the necessity of constructing manholes in which to place the group transformers; (2) a larger number of sources of trouble than with the series system.

The following table gives a comparison of the system with regard to possible voltage to ground from the lamp socket and the cost per standard. The figures given apply to 100 c.p. lamps installed in locations where it is possible to use parkway cable and assuming that 35 KVA regulators will be used to supply constant current to the entire circuit and that in addition 10 KVA series transformers will be

used to supply the groups in the group system.

	Maximum Voltage	Cost per Standard
Straight series	5300	110.28
Individual transformer	11	130.28
Group	757	99.78

The Conduit System.—Cable for street lights can be installed in either of two ways. If conduit is laid in the ground, lead covered cable can be pulled into the conduit and connected to the various pieces of equipment. If no conduit is installed, lead-covered cable with two layers, each of steel tape and tarred jute around it, can be laid directly in the earth with no other protection, and connected to the various pieces of equipment. The main advantages of the conduit system lie in the fact that the cable can be repaired at any time without any excavation, while the advantage of the steel taped cable system lies in the lower first cost.

The type of lighting equipment to meet the needs of the different districts can be summarized as follows: (1) the residential section—100 c.p. lamps on 10½-ft. standards, alternate standards on opposite sides of the street, and steel taped cable; (2) the semi-residential section—250 c.p. lamps on 12½-ft. standards, spaced as above, and steel taped cable; (3) the semi-business section—250 c.p. lamps on 12½-ft. standards, spaced as above, and lead covered cable in conduit; (4) the business section—250 c.p. lamps on 12½-ft. standards placed opposite one another and lead covered cable in conduit. Alternate lamps on separate circuit to be turned out at midnight.

Costs.—Fairly typical costs per block of 400 ft. for the above layouts, using the group system, with an inexpensive standard and a ball globe are given below. These figures were worked out for a particular locality and are comparative only, local conditions affecting them. Court costs, supervision, inspection and cost of assessment roll for local improvements have not been included.

RESIDENTIAL LIGHTING

5 10½-ft. standards complete at $53	$ 265.00
5 20x20x24-in. foundations at $7.50	37.50
920 ft. 1000-volt steel-taped cable at $240 per 1000 ft.	220.80
50 ft. 1000-volt twin conductor lead-covered cable at $180 per 1000 ft.	9.00
0.40 KW station equipment at $43.40 per KW	17.32
0.40 KW distribution equipment (mains, manholes and transformers) at $246.40 per KW	98.56
Total	$ 648.18

SEMI-RESIDENTIAL LIGHTING

5 12½-ft. standards complete at $65	$ 325.00
5 24x24x30-in. foundations at $8.50	42.50
920 ft. 1000 volt steel-taped cable at $240 per 1000 ft.	220.80
60 ft. 1000-volt twin conductor lead-covered cable at $180 per 100 ft.	10.80
0.825 KW station equipment at $43.40	35.72
0.825 KW distributing equipment at $264 per KW	218.13
Total	$ 852.95

SEMI-BUSINESS LIGHTING

5 12½-ft. standards at $65	$ 325.00
5 24x24x30-in. foundations at $8.50	42.50
5 18x18x20-in pullboxes at $22	110.00
920 ft. 1000-volt lead-covered cable at at $100 per 1000 ft.	92.00
60 ft. 1000-volt twin conductor lead-covered cable at $180 per 1000 ft.	10.80
920 ft. 1-duct conduit in place at $1.60 per lin. ft.	1,472.00
0.825 KW station equipment at $43.30 per KW	35.72
.825 KW distributing equipment at $264.40 per KW	218.13
Total	$2,306.15

BUSINESS LIGHTING

10 12½-ft. standards complete at $65	$ 650.00
10 24x24x30-in. foundations at $8.50	85.00
10 18x18x24-in. pullboxes at $22	220.00
1840 ft. 1000-volt twin conductor lead-covered cable at $180 per 1000 ft.	21.60
920 ft. 2-duct conduit in place at $1.70 per lin. ft.	1,564.00
1.65 KW station equipment at $43.40 per KW	71.44
1.65 KW distributing equipment at $264.40 per KW	432.26
Total	$3,232.30

These totals give the following unit costs:

	Cost per Run. ft. street	Cost per Property fnt. ft.	Cost per Stand.
Residential lighting	$1.41	$0.81	$129.60
Semi-residential lighting	1.86	1.07	170.60
Semi-business lighting	5.01	2.88	230.62
Business lighting	7.04	4.04	323.23

Illumination of Highways.—It is becoming desirable to furnish some illumination on the main highways in order to render the use of bright, glaring headlights unnecessary, thereby avoiding a number of accidents which are caused by the glare blindness. The problem of highway illumination is greatly different from that of city streets. Since the traffic is almost entirely vehicular, uniformity of illumination is not of so great an importance. The main object is to make it possible to perceive objects or bad spots ahead of the car. Three factors contribute to this perception: (1) direct illumination of the object by the light source; (2) silhouetting of the object against the bright area under the lighting unit; and (3) reflection from the surface of the road-

way. Probably the least important is the direct illumination, and for this reason large units spaced fairly far apart can be used.

The lamps should be of the constant-current series type, for which a regulator is necessary. On the basis of 400 c.p. spaced approximately 400 ft. apart, one 35 K.W. regulator will light about 10 miles of roadway. The cost per mile for such an installation would be approximately $1,700 if a pole line is available, and it would only be necessary to support and string the wire and mount the lighting units; and approximately $2,500 if it is necessary to set poles.

Traffic Census on British Highways

Extract From an Address Presented Before Institution of Civil Engineers

By HENRY MAYBURY

Director General, Roads Department, Ministry of Transport.

Very shortly there will be published, I hope, the results of the general traffic census taken last August on all the first-class roads of the United Kingdom.

The total length of the roads ranked by the Ministry of Transport as first-class is upwards of 22,000 miles, and the count was taken at 3,808 points. The more populous the area, the shorter the intervals.

Great care was needed in the selection of the observation points so as to secure typical and representative results which will be capable of useful comparison a few years hence with a subsequent census taken at the same spots. Experience having shown that traffic intensity is usually highest in August, owing to the seasonable prevalence of motor buses and motor coaches, that month was selected as the most suitable period. The count was accordingly taken for a period of seven successive days in August for 16 hours a day—i. e., from 6 a. m. to 10 p. m.

Care was taken to choose in each locality a week free from abnormal traffic-currents caused by bank holidays, race meetings, fairs, etc.

The cost of the census worked out at less than £8 per point, and particulars were uniformly booked by each enumerator under a variety of heads, such as: Cycles, motorcycles, motor cars, motor vans, motor omnibuses, motor lorries (rubber tired), motor lorries (steel tired), trailers, traction engines, every variety of horse-drawn vehicles, tramcars, and various denominations of cattle.

Perhaps one of the most interesting facts emerging from the census is the extraordinarily irregular distribution of traffic along our great trunk roads. Thus on the London-Bath road near Brentford the weight of traffic registered was over 14,000 tons a day, whereas 3 or 4 miles farther west the figure dwindles to 5,860 tons. Or take another great route, London-Manchester-Carlisle, which is now designated "A6" on the Ministry of Transport's classification maps. At a point 34 miles north of London the traffic falls short of 500 tons per day. In the neighborhood of Leicester and Derby the figure is between 3,000 and 4,000, while at Lancaster a total of 8,000 tons is recorded.

As we possess, apart from these traffic statistics, a general knowledge, derived from highway authorities' estimates, of the cost of maintenance of all classified roads, it is possible to deduce some instructive figures showing the relation between the expense of road upkeep on the one hand and the tonnage carried by the highway on the other hand. A few figures taken almost at random may interest you; they were intended to throw some light on the problem of the transport of rural produce.

For this purpose we collated the particulars of the traffic using three well-known first-class roads and the cost of road upkeep.

The roads were:

	Miles
A 10. London-Cambridge-Kings Lynn	99
A 20. London-Maidstone-Folkestone	60
A 41. London-Aylesbury-Bicester	47

The lengths, you will observe, are sufficient to allow fair scope for the application of averages.

The cost of upkeep taken over the whole length of each road ranges from £700 per mile in one case to £980 in another. If you divide these figures by the average of the traffic tonnage recorded at all points on each road you arrive at a curiously uniform figure of 32d. or 33d. per ton-mile.

Figures such as these can only be used with great caution, especially if it is desired to set up comparisons between road transport and rail transport.

Experimental Oiled Roads in Illinois

Tests in Henry and Christian Counties, Illinois, of Use of Oil for Treatment of Earth Roads

By H. F. CLEMMER and F. L. SPERRY
Engineer of Materials and Assistant Engineer of Materials, Illinois State Division of Highways

The Illinois Division of Highways, in co-operation with the highway authorities of Henry and Christian counties, has started an exhaustive series of tests with the use of oil for the treatment of earth roads.

The construction of two experimental oiled roads was completed in August. One of these roads is located in the northwestern part of the state near Cambridge in Henry County. The other is located one mile from Rosemond, near Pana, in the south central portion of the state. These locations have been selected with the view of securing the fullest range of soil and climatic conditions which exist between northern and southern Illinois. The location of the experiments is believed to be of much importance because experience has indicated that both soil and climatic conditions are important factors in the life of an oiled earth road.

The Cambridge test road is about 3 miles in length and comprises 15 sections, each 1,000 ft. in length. The Rosemond road is about 2½ miles in length and comprises 16 sections, each 800 ft. long. Each of the 31 sections making up the two roads has been given a different oil treatment; 11 different kinds and grades of road oil, including all available commercial varieties of oil having been used. fourteen sections employing varying quantities of oil and numbers of treatments, varying from 1 qt. per square yard applied at one application to 1 gal. per square yard applied at intervals throughout the season, have been constructed. Other sections have been constructed employing varying methods of maintenance and application of oil.

Experimental Oiled Road.

Both of the experimental roads are now open and subject to normal traffic conditions. The Rosemond road is subject to only comparatively moderate traffic, whereas the Cambridge road carries a heavy automobile traffic. The roads are under close observation and their behavior will be carefully watched and the results of traffic recorded.

It is hoped by these experiments to secure much valuable data on the use of oil as a means of maintaining

earth roads under conditions which exist in Illinois.

Experiment With Oil Applied in Varying Quantities and Numbers of Treatments.—This series of tests occupies a total of 13 sections of both roads and covers the full range of treatments ordinarily used on dirt roads in Illinois, beginning with a minimum treatment of 1 qt. per square yard to a maximum of 1 gal. applied at intervals throughout the season. The same kind of oil was used throughout this series of tests except that the oil used at Cambridge was of a heavier grade than that used at Rosemond.

Descriptions of the individual sections follow:

Section 1-R.* Initial treatment, ¾ gal. per sq. yd. in three applications. No further applications will be made on this section throughout the year.
**Oil No. 1-R used.
Total treatment, ¾ gal. per sq. yd.

Section 2-R. Initial treatment, ¾ gal. per sq. yd. in three applications to be followed by one similar application in the fall.
Oil No. 1-R used.
Total treatment, 1 gal. per sq. yd.

Section 3-R. Initial treatment, ½ gal. per sq. yd. in two applications to be followed by one similar application in the fall.
Oil No. 1-R used.
Total treatment, ¾ gal. per sq. yd.

Section 4-R. Initial treatment, ½ gal. per sq. yd. in two applications to be followed by one similar application in the late summer and another application in the fall.
Oil No. 1-R used.
Total treatment, 1 gal. per sq. yd.

Section 5-R. Initial treatment, ½ gal. per sq. yd. in two applications. No further applications on this section.
Oil No. 1-R used.
Total treatment, ½ gal. per sq. yd.

Section 6-R. Initial treatment, ¼ gal. per sq. yd. to be followed by one similar application in the late summer and another application in the fall.
Oil No. 1-R used.
Total treatment, ¾ gal. per sq. yd.

Section 7-R. Initial treatment, ¼ gal. per sq. yd. to be followed by one similar application in the fall.
Oil No. 1-R used.
Total treatment, ½ gal. per sq. yd.

*"R" refers to the Rosemond road and "C" to the Cambridge road.
**For analyses and descriptions of oils see Table I.

Section 6-C. Initial treatment, ½ gal. per sq. yd. in two applications. No further applications to be made during the year.
Oil No. 2-C used.
Total treatment, ½ gal. per sq. yd.

Section 7-C. Initial treatment, one application of ¼ gal. per sq. yd. to be followed by one similar application in the fall.
Oil No. 2-C used.
Total treatment, ½ gal. per sq. yd.

Section 8-C. Initial treatment, one application of ¼ gal. per sq. yd. A similar application was made on Aug. 8, 60 days after the initial treatment was applied. One further application will be made in the fall.
Oil No. 2-C used for initial application.
Oil No. 8-C used for second application.
Total treatment, ¾ gal. per sq. yd.

Section 9-C. Initial treatment, ½ gal. per sq. yd. in two applications. A similar application was made on Aug. 8, 60 days after the initial treatment was applied. One further application will be made in the fall.
Oil No. 2-C used for initial applications.
Oil No. 8-C used for application made Aug. 8.
Total treatment, 1 gal. per sq. yd.

Section 10-C. Initial treatment, ½ gal. per sq. yd. in two applications to be followed by one similar application in the fall.
Oil No. 2-C used.
Total treatment, ¾ gal. per sq. yd.

Section 11-C. Initial treatment, ¾ gal. per sq. yd. in three applications. No further applications to be made during the year.
Oil No. 2-C used.
Total treatment, ¾ gal. per sq. yd.

Experiment With Different Kinds of Oil.—In this series every commercially available kind of type of oil has been used. Nine sections are occupied by these tests.

By reference to "kind" of oil in these tests is meant a distinct chemical type of oil, according to the process of refining or the geographical source of the crude form which the oil has been prepared. By a "skimmed" oil is meant a residuum from a "skimming" plant, that is a refinery employing non-pressure or straight distillation methods of refining. A "cracked" oil is one which has been refined under the influence of high temperatures and pressures and thus chemically decomposed or "split" up into the lighter hydrocarbons and carbon to increase the gasoline yield. The term "cracked pressure tar resi-

due" is applied to oils refined by a certain cracking process in which the residuum is so altered as to have many of the chemical characteristics of tar. "Mexican asphaltic oil" is oil obtained from Mexican petroleum which has a natural asphalt base and, therefore, is well adapted to road work and the manufacture of asphalt. "Cut-back asphaltic oil" is a Mexican or other natural asphaltic oil which has been reduced or thinned to a working consistency by the addition of light distillate.

All available types of oil in the market have been included in the experiments and the product of any individual refinery will fall in to one of the classes of oil under test. To insure fair competition between different oils, each one has in so far as the refiners would supply it been used in equivalent grades, the grading being based on the specific viscosity test at 60° C. and the solid residue test. On the Cambridge road oils having a specific viscosity of as near 21.0 as possible and meeting the Illinois E-3 specification as to solid residue of 100 peneration were used. On the Rosemond road oils having a viscosity at 60° C. of 12.0 and meeting the Illinois E-2 specification requirements for solid residue were used.

Section 11-C. ¾ gal. per sq. yd. in three applications of cracked pressure tar residue (Oil No. 2-C).

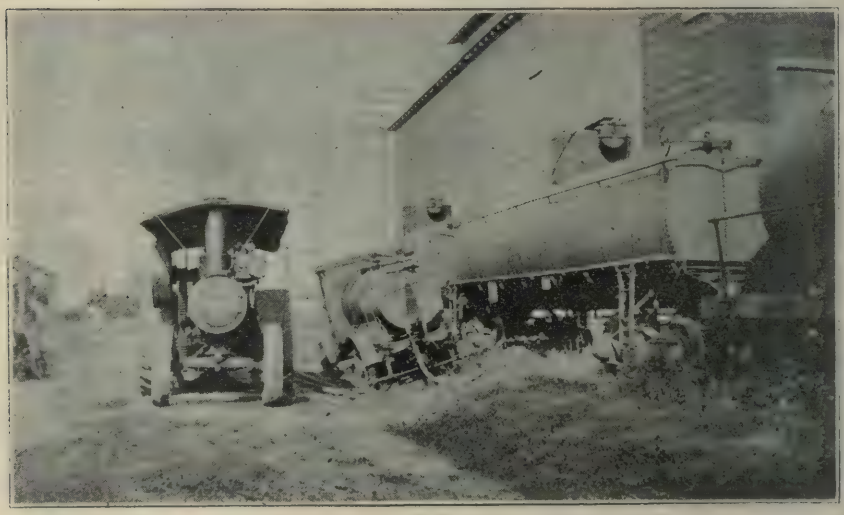
Section 12-C. ¾ gal. per sq. yd. in three applications of cut-back asphalt base oil (Oil No. 5-C).

Section 13-C. ¾ gal. per sq. yd. in three applications of Mid-continent cracked residuum (Oil No. 4-C).

Section 14-C. ¾ gal per sq. yd. in three applications of Mexican asphaltic base oil (Oil No. 3-C).

Section 15-C. ¾ gal. per sq. yd. in three applications of Mid-continent skimmed oil (Oil No. 1-C).

Section 11-R. ½ gal. per sq. yd. in two applications of Mid-continent skimmed oil refined from Illinois crude (Oil No. 3-R).



Heating Oil With Jet of Live Steam Conducted by Pipe Through Dome of Car.

Section 12-R. ½ gal. per sq. yd. in two applications of Mid-continent skimmed oil refined from Arkansas crude (Oil No. 5-R).

Section 13-R. ½ gal. per sq. yd. in two applications of blended Mid-continent skimmed and Mexican asphaltic base oil (Oil No. 4-R).

Section 14-R. ½ gal. per sq. yd. in two applications of Mid-continent cracked oil refined from Oklahoma crude (Oil No. 6-R).

Note: Observations of cracked pressure tar residue will be made on Section 5-R.

Experiment With Different Grades of Oil.—The term "grade" is used here in a different sense than "kind." Any of the kinds or types of oils mentioned in the preceding series of tests

might come in a number of grades ranging from light, thin oil for cold application to very thick, heavy products for hot application. In this series of tests only those grades commonly employed on earth roads have been used.

Section 5-C. ¾ gal. per sq. yd. in three applications of light oil showing 55 per cent of solid residue of 100 peneration.
Oil No. 6-C used.

Section 3-C. ¾ gal. per sq. yd. in three applications of extra heavy oil showing 72 per cent solid residue of 100 penetration.
Oil No. 7-C used.

Section 9-R. ¾ gal. per sq. yd. in three applications of medium grade oil showing 67 per cent of residue of 100 penetration.
Oil No. 2-R used.

Note: Sections 5-C and 3-C are comparable with Sections 11-C to 15-C, inclusive, and Section 9-R is comparable with Section 1-R and with Sections 11-R to 14-R, inclusive.

loosening of the wearing surface which sometimes happens under the influence of frost action.

Section 4-C. One application amounting to ¼ gal. per sq. yd. of light oil followed as soon as absorption was complete by one application of heavier oil.
Oil No. 6-C used for priming coat.
Oil No. 2-C used for final application.

Section 8-R. One application of ¼ gal. per sq. yd. of E-2 grade oil followed as soon as absorption was complete by one application of E-3 grade oil.
Oil No. 1-R used for priming coat.
Oil No. 2-R used for final application.

Experiment With Varying Widths of Oiled Roadway.—While an oiled strip 16 ft. or under is desirable even where traffic is light, many roads in Illinois are oiled in much narrower widths. The following sections have been oiled in less than standard widths to compare with the wider sections:

Section 1-C. Oiled by applying two 8-ft. strips down each side of the road and one 8-ft. strip down the center, thus making an oiled roadway 16 ft. wide with a single application on the outer 4 ft. at each side and two applications down the center. By this method of oiling a 16-ft. oiled roadway is obtained with the same quantity of oil that would be required for a 12-ft. road with two applications the entire width.
Oil No. 3-C used.

Oil Heating and Distributing Apparatus at Cambridge.

Experiment With Priming Coat of Light Oil Followed by One Application of Heavier Oil.—An initial application of light oil has been used in this series of tests followed by an application of heavier oil. The use of the coat of light oil is analogous to the use of the priming coat of thin paint which painters use on new wood surfaces. It is contended by some that the coat of light oil will give depth of penetration and serve to bond the wearing mat to the subgrade, thus preventing scaling and

Section 2-C.	Oiled with two applications, 12 ft. wide. Oil No. 3-C used.
Section 10-R.	Same treatment as Section 2-C except oil No. 2-R used.
	Maintenance
Section 15-R.	This section shall receive no drag or other maintenance subsequent to oiling.
Section 16-R.	This section is under intensive drag maintenance.

Different types of drags and maintainers will be tested out on other sections in an effort to arrive at the most efficient and economical method of maintaining an oiled road.

Traffic Tests.—It is evident from ordinary observations that different kinds of traffic exert a markedly different effect on an oiled road. Narrow steel tires seem to cut up and rapidly destroy an oiled surface while on the other hand pneumatic tires exert an ironing effect which is highly beneficial if not essential to the formation of a satisfactory wearing surface. A limited number of traffic tests will be conducted in order that the effects of different kinds of traffic may be studied.

Soil and Drainage Conditions.—The sites chosen for the experiments represent average Illinois conditions. At Cambridge the soil consists of brown silt loam with strips of black clay loam in the low places. The same general type of soil occurs at Rosemond, but it is less dense and therefore not so gummy and sticky when wet and is more easily ground to dust in dry weather. Both roads are supposedly well drained and are free from deep cuts or excessive grades.

Grading and Preparation of Road for Oiling.—Both roads are graded to a width of 24 ft. and carry an average crown of about 9 in. The Rosemond road had not previously been oiled but was graded as a state aid improvement in 1916. No grading was required on this road, it only being necessary to prepare the surface for oiling. The road was given careful drag maintenance for about a month before oiling and just prior to spreading the oil was given a final smoothing up, using a heavy, 3-way drag on some of the sections and a small, patrol grader on others. The soil on this road is inclined to be light and silty and easy to work. With very little work the surface was brought into perfect condition for oiling.

Experimental Oiled Road.

The Cambridge road had been oiled the previous year but had broken up during the winter and spring so that little or no oil was in evidence at the time it was selected for the experiment. This road required considerable reshaping to put it in suitable condition for oiling. Grading was started May 18 and completed May 25, after which the road was kept carefully dragged until final prepara-

tion for oiling was begun. The finishing of the surface was accomplished with a 4-sectional blade maintainer with a mould-board drag attached behind. By means of the maintainer, a perfectly smooth surface free from all waviness or unevenness was obtained. The drag served to crush up all traces of clods or sods deposited at the discharge end of the maintainer blade.

Application of Oil.—The Cambridge road was oiled between June 14 and June 30 and the Rosemond road during the last three days of June. All oil was heated to a temperature between 150 and 160° F. before application. At Rosemond the oil was heated in the tank cars by conducting a jet of live steam directly into the oil through a ¾-in. pipe entering the car through the dome. Laboratory tests revealed that about 3 per cent of water was introduced into the oil by this method of heating. About four hours were required to bring the oil to the required temperature. At Cambridge the oil was heated by means of a patented instantaneous steam heating device as the oil was pumped from the car to the distributor. Practically no water was introduced into the oil by this method of heating.

Pressure distributors of a late type, without heating attachments and equipped with pneumatic tires, were used on both roads. Those used at Cambridge had a capacity of only 460 gal. and were capable of attaining a high speed. This type of distributor has the advantage over the heavier types in that it does less damage to the prepared grade than heavier machines or machines equipped with solid tires. One of the machines used at Rosemond had a capacity of about 600 gal. and the other about 750 gal. The latter machine proved too heavy as it caused some deformations of the prepared road surface.

On both roads the distributors were carefully adjusted to spread at the rate of ¼ gal. per square yard. Each application was allowed to be completely absorbed before applying the succeeding coat. When more than ¼ gal. per square yard was applied at one time, it was found that the oil tended to flow to the sides of the road before it was absorbed.

Table I—Analysis of Oils

Oil Number	Name of Oil	Specific Gravity at 25° C.	Engler Viscosity at 60° C.	Total Bitumen, Per Cent	Bitu. Insoluble in 86° Be. Naphtha, Per Cent	Fixed Carbon, Per Cent	5-hr. Evaporation Loss, Per Cent	Flash Point, °C.	Solid Residue of 100 Penetration, Per Cent	Ductility of Solid Residue
1-C	*	0.939	21.4	99.7	1.4	2.9	.....	210	67	13
2-C	**	1.041	18.7	99.8	12.4	9.1	.....	183	58	100+
3-C	***	0.963	23.5	99.9	15.6	8.0	5.6	105	63	100+
4-C	****	0.948	17.1	99.3	5.6	4.1	.....	195	59	2
5-C	*****	0.961	15.6	99.8	14.9	7.5	15.2	98	59	87
6-C	******	0.938	10.3	99.9	6.7	4.3	5.4	95	55	42
7-C	**	1.055	32.6	98.7	17.1	10.9	.....	185	72	100+
8-C	******	0.953	21.6	99.8	9.6	6.0	.....	123	62	36
1-R	**	1.031	11.3	99.8	12.5	8.7	.....	185	52	100+
2-R	**	1.043	22.1	99.8	13.1	8.9	.....	195	58	100+
3-R	**	0.938	13.7	99.9	2.9	2.9	.....	190	56	11
4-R	******	0.947	10.6	99.9	5.6	4.3	4.5	115	55	21
5-R	*	0.943	13.6	99.9	8.6	5.1	.....	129	58	41
6-R	****	0.945	10.3	99.5	6.1	4.0	.....	155	52	2.5

* Mid-Continent skimmed oil.
** Cracked pressure tar residue.
*** Mexican asphaltic oil.
**** Mid-Continent cracked oil.
***** Cut-back asphaltic oil.
****** Mid-Continent—Mexican Blend.

Sampling Fine Aggregate for Concrete Highway Construction

Practical Methods Used by the North Carolina State Highway Commission

By G. W. HUTCHINSON
Assistant Engineer, State Highway Commission of North Carolina

Delays in securing test results and subsequent acceptance or rejection of materials entail considerable expense to the contractor doing highway work, and to the producer who endeavors to furnish the material. This expense, while directly borne by either the contractor or the producer, is ultimately paid by the state or municipality, on account of its reflection in subsequent bids.

Many localities are handicapped by circumstances which will require forethought and investigation if they are to construct economic highways of the hard surfaced type. Some of these circumstances refer to securing fine aggregate for portland cement concrete, among which are:

1. No knowledge of quantity and quality of available local materials before the project is let.
2. No possibility of guaranteeing such local material available to the contractor, on account of either insufficient or inaccurate data on the particular deposit.

Saving Results From Preliminary Investigation.—It is unfortunate that money for preliminary investigation of this kind is generally hard to secure, as the general opinion is that such detail will increase the cost of construction. On the contrary, considerable saving results many times, and this information relieves the contractor who expected to use the local material in case an investigation proves opposite to the usual opinion prevalent among those not wholly familiar with the requirements for fine aggregate. On the other hand, if an investigation proves that suitable material is available, it allows the state to get the benefit between the cost of the local sand and an imported material, by guaranteeing the deposit.

The demand for fine aggregate in North Carolina is in excess of the supply. This is not wholly on account of sand not being found, but partly on account of lack of transportation facilities. This has led to a movement on the part of the contractor to secure local material whenever possible.

Local Sand Deposits.—Recently the deposits of sand located by the material survey parties were guaranteed by the state, with reservations regarding the amount of sand available for a given deposit. In cases where the material did not meet the requirements, an addition to the cement content was required, and the additional cement furnished the contractor free of charge, provided his bid was based on the local material previously located by the state representatives.

The present standard sand test is realized to be inadequate when dealing with materials from deposits of different qualities and characteristics. Many sands when tested by these methods would be rejected, but if certain of these were made into concrete in the proportions proposed for use, a concrete can be obtained, which will equal, and sometimes be superior to one made with either Standard Ottawa sand or a natural sand giving the same strength as Standard Ottawa sand in tension or compression when made into mortar by standard methods.

The present method generally used for sampling is also open to criticism. The laboratory depends upon the engineer in the field to get samples of the material for test, and the contractor depends upon him to do this promptly. If the sample is not taken promptly, an unnecessary and expensive delay to the contractor results until the tests are available, as it means closing down the work many times until they are received, and if the work proceeds without waiting tests results, it is useless to waste money on the tests. The practice of allowing materials to be used on the contractor's responsibility should be discouraged, as it is apt to be very expensive, and the gambling element between the state and the contractor should be eliminated.

The time limit for testing is im-

portant, especially in large states where it very often takes two days or more for the sample to reach the laboratory. Assuming that the sample has been taken on time, the next question asked is if it represents the material sampled, and also how large a quantity the sample represents. A sample of cement is supposed to represent not over 200 bbl., but many times a sand sample which is of as much and sometimes of more importance, especially when dealing with small stream deposits, represents several thousand cubic yards. In dealing with the usual stream sand this is entirely wrong. Many bank sands vary too much in quality throughout a given area and depth to allow a fair test to be made from the 15 lb. sample usually submitted. Stream sands, especially from the smaller creeks and rivers, will vary over night. Also 500 ft., up or down stream, may reveal an entirely different class of material.

With conditions as stated, it can readily be seen that the acceptance of fine aggregate for concrete work must be handled in a practical way, if local material is going to be economically used, and delays on account of testing eliminated.

Co-operation of Field and Laboratory.—It is just as necessary for the field to co-operate with the laboratory in sampling the materal as it is for the laboratory to co-operate with the field in testing it. As an example of the laboratory co-operation, there are but four hours leeway upon which the Concrete Laboratory of the Division of Tests and Investigations, North Carolina State Highway Commission have to operate. This means that from the time the sample is received until notification of the seven-day test results is received in the field, the Concrete Laboratory has but four hours to spare between the time actually necessary for the preparation, testing and reporting results, and the time given on the card received in the field, which acknowledges receipt of the sample and gives the date when the results of the tests should be in the hands of the engineer submitting the sample. When it is realized that over 16,000 samples were tested in 1922 by the whole division, and nearly one-half of these were tested in the Concrete Laboratory, the necessity for organization and co-operation on the part of the field is important if the laboratory is to function properly.

System Used in North Carolina.—The system in use by the Division of Tests and Investigations with reference to sand sampling divided the material into three classes on an arbitrary basis:

1. Class known as commercial pit.
2. Class known as local pit.
3. Class midway between the two.

The distinction between the first two is with reference to inspection. Any pit producing sufficient material for state highway use to justify the expense will be provided with an inspector. This inspector takes daily samples of the material at the pit, and sends them direct to the laboratory, and at the same time makes all the necessary inspection of the plant operation and material, as well as any of the minor tests deemed advisable. When a shipment is made for state highway work it has a seal on the car, and the resident engineer is satisfactory. By means of the seal and the card system, the resident engineer knows that if he receives the card or finds the seal on the car the material is acceptable for use. Material received under this system which would not pass visual inspection or vary from the run of previous shipments is reported to the main office of the Division of Tests and Investigations, and the material is withheld from use waiting investigation of both the material and the plant inspector who accepted it. This system allows the contractor to use the material direct from the cars if desired and eliminates any delays or expense of demurrage on account of testing as long as uniform material is produced.

The second class is known as local pit or one where no inspection is maintained, and comes under the "Local Sand Requirements" in the specifications as follows:

Preliminary tests of local sand shall be considered as an indication of their quality. These tests will be made upon the request of any parties entitled to this consideration and need not be officially taken by representatives of the State Highway Commission unless requested.

In case the preliminary test indicates that the sand is of the quality required for fine aggregate in concrete mixtures, it will be necessary to stock pile the material in not less than two hundred (200) cubic yards units in order that an official sample

may be taken that will fully represent the material proposed for use. When a smaller quantity is required to complete the work in which it is desired to use the materials, or if impracticable on account of local conditions to stock pile this quantity, the maximum amount possible to stock pile will be accepted as a unit.

The material in the stock pile will be sampled officially by representatives of the State Highway Commission and forwarded to the laboratory for test purposes. If the test results of the official samples from the stock pile indicate that the sand does not meet the requirements, an adjustment of the cement content in the mixture may be allowed within reasonable limits, by the addition of the proper amount of cement as directed by the Testing Laboratory based upon the test results of the official sample. Check tests will be made when requested by the contractor in writing, but the use of the material will be governed by the original test until subsequent test results are available.

The contractor will be required at all times to keep sufficient sand stockpiled in advance to allow test results of the local sands to be secured, unless permission in writing is secured from the engineer to the contrary.

It can be seen that if the contractor stock piles material sufficiently in advance, and the engineer forwards the samples with reasonable promptness, there will be no delay in the use of the material, and decisions are available to allow the intelligent use of the material in case it does not meet the standard requirements. The stock pile clause is extremely important when applied to creek sands on account of the tendency to run nonuniformly. The system necessitates rehandling the sand, but this item should be included in the contractors' proposal at the time it is submitted.

Sampling by Means of Test Holes.—An exception to the stock pile clause can be allowed under certain conditions which will be of benefit to both the state and the contractor. This is with reference to bank sands which can be sampled in the bank by means of test holes. For this purpose, the pit should be staked out over a given area, and test holes dug on not more than 25 ft. centers over this area, and to the depth desired to excavate the material.

The test holes should be approximately 2 or 3 ft. square, to allow representative sampling and proper inspection of the material in the bank. For sampling, a sharp instrument should be scraped with uniform pressure from the bottom to the top of the face of the cliff, on at least four sides of the hole. The operation should be repeated until about 50 lb. from each hole has been secured for a sample. The overburden or stripping should not be included in the sample as this will be required to be removed from the pit before the pit is accepted. This applies to all pits, regardless of any requirements for washing.

At the time the pit is sampled, a sketch of its location, as well as the location, depth, etc., of the test holes should be made and forwarded with the sample. Remarks regarding the variation of the material in different strata from top to bottom should be included for additional information.

Test specimens of concrete are made in the laboratory, using the samples submitted as fine aggregate, in the proportions called for by the specifications, and as soon as the test results are available, the sand in the entire bank or in certain parts is accepted, adjusted for cement, or rejected, upon the basis of the value of the material when made into concrete.

The third class is practically the same as the first, except that the engineer on the work samples the material immediately upon receipt of the shipment, although the work is not held up waiting test results of the sample. In this class are placed all pits (bank sand only) which appear to have a uniform material after stripping has been removed, but do not show sufficient shipment of material to warrant the expense of an inspector. The samples submitted by the resident engineer are made into composite samples and tested twice weekly.

It can be readily seen that when the testing of fine aggregate is connected with the practical and economic use of the material in the field, the laboratory work itself is by no means the last word in protection against the use of inferior material. When operations are of such a large and varied nature as are found in states with large highway programs, the greater responsibility rests on the men in the field. The problems they encounter in handling different situations regarding fine aggregate should be taken up with the laboratory so

that as much standardizing as possible can be carried on. They should look upon the laboratory as a guide and not feel that it is merely a place to shoulder responsibility for delays. Its function is to protect the state from the use of improper materials, but it cannot perform this function unless it receives the full co-operation of the engineers in the field.

Engineers' Participation in Public Affairs

Extract From Address Presented Before Engineers Society of St. Paul

By JOHN H. MULLEN

The participation of engineers in public affairs of Minnesota has been a very potent factor in the development of the state, but this participation has generally been limited to promotional work by society groups, for the purpose of bringing about new legislation affecting only engineering projects. In this respect the engineers of the state have been very successful, as may be evidenced by the progress brought about in state laws relating to highways, drainage, sanitation and contracting, and in city ordinances governing city planning, building codes and structural inspection, for all of which the engineering societies have due credit, and it may truthfully be said that they have been primarily responsible for a considerable part of this development.

Until just recently, however, this original work had not been followed up. It has been customary, after the enactment of new engineering policies into law or ordinance and the first flush of enthusiasm has waned, to leave the further necessary legislation and public support to be promoted by those engineers directly affected. Herein lies the opportunity for service by the engineering fraternity as a whole in its relation to public affairs.

It should be a matter of professional principle for all engineers to be well informed on public matters affecting general engineering work and to exert some effort to direct the forming of public sentiment and opinion which really governs administrative policies and legislation. This seems to be the only way to make progress under present conditions for engineers are not generally represented in legislative bodies. The last Minnesota legislature had but one engineer out of a total membership of 200, and there was none in the previous season. Very seldom is an engineer to be found in a city council, and until the engineers do take active interest in political matters we cannot hope for the best results in public work.

Within the last few years there has been a marked development in this state in the participation of engineers in public affairs through the organization of the Minnesota Federation of Architectural and Engineering Societies. This federation of technical organizations can become of great value and service to the community but only through the active help of the individual members. Its board of directors has given freely of time and effort successfully to promote and develop public policies affecting engineers' work. We cannot, however, expect the directors to carry this entire burden but must develop in the individual a consciousness of responsibility for the support of those things which are important to engineers as a whole, even though some such matters have no connection with or bearing on the work of the particular individual in question. The tendency, we find, is to leave too much of this work to our committees and directors; becoming so much engrossed in the details of our own activities that the broader development of engineering practice and influence is retarded through lack of support.

One of the judges of our supreme court in a public address recently stated that of the evidence brought out in litigation, that which was offered by engineers was given greater credence than perhaps from any other source as it is recognized that the engineer's testimony and opinion are based upon a careful investigation of facts and a logical application of scientific principles. This statement coming from one who has been on the bench for more than 15 years is food for thought and is an indication of the force which may be exerted by the engineers through concerted well directed effort in matters of public policies. Engineers should not shirk their responsibility through a false idea that politics is not for the professional man. Politics is the science of civil government and would be much the better for the participation in it by engineers.

Selection of Types of Asphalt Pavement With Reference to Local Materials

Paper Read Before Recent Asphalt Convention at Denver, Colo.

By ROY M. GREEN
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During the year 1921 over $120,000,000 was expended for the improvement of the streets in the 252 largest cities in the United States. During the same year the sum of $34,742,791 was expended for sanitation and the promotion of cleanliness, and $55,396,376 for schools in the same cities.* Over 39 per cent of all the outlay of funds in these cities was expended for highway improvement. More than twice as much was spent for street improvement as for schools and nearly four times as much for streets as for sanitation. These statistics indicate the relative magnitude of the street paving problem as compared with other municipal undertakings on the basis of financial importance.

Regardless of the manifest importance of this problem in every city in the United States we still find the laymen of the various cities, through their city councils, or commissions, feel justified in taking from the hands of their engineers the important problem of the selection of the type of pavement to be used in any location. The success of the street system, as a transportation medium, is entirely dependent upon this selection, yet many members of city councils feel themselves qualified to select the type of pavement to be used. These same men would hesitate to even make a recommendation regarding the design of a sewer or water-supply system, where much less money is involved in the enterprise.

Authority of Engineer.—Although it is manifestly a fact that this authority should be vested in the engineer we are still confronted with the condition, in many states, where the law delegates this authority to the city council, or even worse, to the abutting property owners within the district to be paved. Without any question, this reacts against the best interests of the public and results in improper selections in many instances, and is one of the greatest contributing causes of the short average life of pavements.

Since the engineer does not have this authority it would seem, at first thought, that a discussion of the selection of types of asphalt pavements with reference to local materials is a waste of time at a meeting of engineers, but this is not true.

Even though the engineer is confronted with this condition he still has great authority in making the selection of type through the fact that he still has practically unlimited authority in the drafting of the specifications for the work contemplated. Let us call this, selection of type by specifications. Unfortunately the engineer too often overlooks the fact that he has this authority and hastily draws up his specifications by simply adopting the standard specifications of one of the national agencies that have adopted such standards, never realizing that his client may suffer great financial loss through such procedure.

There is never a locality where one of the asphalt pavement types does not have a superior economic advantage over all others on account of the availability of some source, or sources, of supply of local materials. In some cases these local materials may be of such a nature that they will not meet the requirements of the specifications of the American Society of Municipal Improvements or of the Asphalt Association. I do not wish to be understood, however, as criticising these specifications, because I most heartily approve of them, and especially those of the Asphalt Association, which I consider as the best group of standard specifications that have ever been prepared, but I do wish to bring out the fact that the blind use of standard specifications is poor engineering and results, in many cases, in higher costs to the owner without a corresponding improvement in the quality of the finished product. On the other hand, it is likewise very poor engineering to specify for the use of local materials without first making a very thorough investigation of these materials. Furthermore, such an investigation should not simply include the usual laboratory tests of these materials but should embrace a thorough examination of the deposits, method of production, quantity and uniformity as well as quality of the ma-

*From "Financial Statistics of Cities for 1921," U. S. Department of Commerce, Bureau of Census.

terial itself. These investigations should be carried on only by persons who are thoroughly qualified, through years of experience in the construction of asphalt pavements, for if they are not, the entire expenditure of the owners' money is then being placed upon an experimental basis, which is a condition never justifiable under any circumstances.

If this procedure is followed it will be possible for the engineer to exercise great influence in the selection of type with reference to local materials if he makes a thorough investigation of the availability of materials of all kinds and then makes sure to include in his specifications a description of the type that can be constructed by using the greatest quantity of low priced material of a quality that is entirely satisfactory for the purpose intended. As soon as bids are received under these specifications the price bid on this type should be low enough to make the selection almost inevitable.

Abuse of Selection by Specification.—Allow me to take two illustrations from cases that have come to my attention in our practice. In one city an engineer asked for bids upon sheet asphalt and asphaltic concrete, coarse aggregate type (in this case called bitulithic). The specifications for the large aggregate for the asphaltic concrete allowed the use of a very inferior grade of broken stone and as a result an aggregate was used having a toughness of only four when tested by the Page impact machine. To have obtained satisfactory large aggregate of broken stone for this work would have required its being shipped for a distance of over 500 miles and from another state at a very high freight rate.

On the other hand the large aggregate for use in the binder course of the sheet asphalt was described in such a way that it required an aggregate of a toughness of 10 and a French coefficient of wear of not less than eight and made it necessary to ship this material a distance of over 500 miles, while there were good commercial deposits of gravel containing materials that would have been entirely satisfactory for that purpose within a distance of less than 50 miles. All other aggregates entering into the construction of the sheet asphalt pavement were even nearer than this, with the exception of the stone dust for filler. The engineer either abused the privilege of selection by specifications and deceived the owners' confidence and wasted their money or he was ignorant. In this case, I believe that it was the former, because he specified also that the binder for the sheet asphalt should contain 7 per cent of limestone dust. The city is no longer a client of the engineer.

Proper Use of Selection by Specification.—On the other hand, let us consider another illustration, where specifications were drawn with the intention of utilizing available materials to the greatest advantage. The city, through its engineer, adopted a specification, which incidentally is not in accordance with any of the standard specifications for large aggregate for binder construction, but is good practice and has been demonstrated as being satisfactory for the work contemplated. Through the use of these specifications, instead of the adoption of one of the standard specifications, the most economical selection was apparent to any unprejudiced party and resulted in the saving of approximately $50,000 on a two-year paving program and the quality of the work did not suffer in the least detail. All the aggregates for this work were obtained within 5 miles of the improvement with the exception of the limestone filler.

In closing, however, I wish to again sound the word of warning against the adoption of any local materials or special specifications unless their adoption is thoroughly investigated by one who is unquestionably qualified to pass judgment upon their utilization of the work contemplated as it would be a serious error in policy to place the expenditure of public money, in such great quantities, upon an experimental basis and it would react against the best interests of all concerned in the construction of roads and pavements.

On the other hand I wish to draw your attention to the economic value of making thorough investigations of all sources of supply of materials for utilization in the construction of asphalt pavements.

New Highway Creosoted Timber Bridges in Alabama

Contracts have recently been let for nine standard highway creosoted timber bridges to be erected in Dale, Conecuh, Houston and Covington counties, Alabama. Three bridges will be 680 ft., 396 ft., and 400 ft. long, requiring a total of 373,554 ft. b. m. of treated lumber, and 14,948 linear feet of creosoted piling. Mr. R. P. Boyd, office engineer, Alabama State Highway Department, gives the following details in September Wood Preserving News:

Square, sound and dense southern yellow pine, without heartwood restrictions, cut to correct size before treatment, is to be used. All sawing or boring into the treated timber will be avoided, and when necessary the cuts or holes will be filled with three coats of boiling creosote oil. The cut surface of the piles at cut off will be protected with three coats of creosote.

The specification calls for the pressure treatment of the timber, injecting 12 lbs. of creosote oil per cubic foot into the lumber and 16 lbs. per cubic foot into the piling.

Foundation piles have a minimum diameter of 8 in. at the tip and 12 in. at the butt. Stringers vary in size from 10 in. x 14 in. x 21 ft. to 6 in. x 14 in. x 14 ft.; caps, 12 in. x 20 ft. 6 in.; sway braces, 3 in x 10 in. x 22 ft. and 24 ft.; wheel guards, 4 in. x 8 in. x 20 ft. 6 in. to 4 in. x 8 in. x 14 ft. 6 in.; railing posts, 4 in. x 6 in. x 6 ft.; railing post blocks, 4 ft. x 6 in. x 14 in.

One feature of construction is the creosoted laminated sub-floor provided with a bituminous wearing surface. This sub-floor consists of creosoted 2 in. x 4 in. x 19 ft. 4 in. timber placed on edge. Each stick is toe nailed to each stringer with two 16d nails and nailed to sub-floor timbers already in place with one 16d nail every 12 in. A 2 in. x 8 in. paving retainer is nailed to the sub-floor every 12 in.

These bridges will have an 18-ft. roadway and are designed with four pile bents to carry a typical 15-ton truck.

New Trade Publications

The following publications of interest to engineers and contractors have been issued recently:

Cold Repair Cement.—The Barber Asphalt Co., Land Title Bldg., Philadelphia, Pa., has issued a useful booklet on Barber brand cold repair cement. It contains instructions on the use of the material for repairing roads and for the construction of railway grade crossings and station platforms.

Coal Hoists and Bodies.—A bulletin dealing with "Universal" coal hoists and bodies has been published by the Universal Hoist & Body Co., Everett, Mass. Illustration of the bodies on various truck mountings, together with data and general information are included.

Road and Street Maintainer.—The Gray Tractor Co., Inc., Minneapolis, Minn., has issued an instructive circular illustrating and describing its combination machine, consisting of a 50 h. p. 8-ton tractor roller, equipped with scarifier and grader.

Snow Plows.—The Good Roads Machinery Co., Kennett Square, Pa., has just issued a new broadside containing much useful information regarding its Champion snow plow.

Steam Rollers.—Steam and motor rollers are the subject of a recent catalog of the Bucyrus Road Machinery Co., Bucyrus, O. The machines are illustrated and described and their specifications are given.

Pumping Outfits.—The Novo Engine Co., Lansing, Mich., brought out a bulletin on its pumping outfits. It contains illustrations, descriptions and specifications for high pressure pumps, diaphragm and centrifugal pumps and deep well pumps. Some useful tables on characteristics of pumping outfits are included.

Snow Plows.—An interesting catalog illustrating and describing its auto truck snow plows has been issued by The Baker Mfg. Co., 506 Stanford Ave., Springfield, Ill. The plows and their use are fully illustrated and described.

Industrial Notes

The Gray Tractor Co., Inc., of Minneapolis, Minn., manufacturers of the Gray giant combination road and street maintainer, has obtained the services of Arthur A. Prausnitz of Chicago, in connection with the sales distribution of the machines in the central district of the United States. Mr. Prausnitz has been connected with the Koppel Co. of Koppel, Pa., as sales manager, with offices in Chicago, for many years, and is well known amongst the trade, having since 1909 devoted his entire time to the investigation and sales promotion of machinery for road construction. Irving G. Jackson, who has devoted many years in the promotion and sales of machines for road construction, is associated with Mr. Prausnitz.

Robert D. Black, branch manager for the Black & Decker Mfg. Co., in charge of the Philadelphia territory, will return to headquarters about the middle of November to take up his new duties as advertising manager for the company. Mr. Black succeeds Mr. Brogan as advertising manager, effective Jan. 1, 1924, at which time Mr. Brogan will take up his new work in connection with G. W. Brogan, Inc., which concern will handle the advertising of the Black & Decker Mfg. Co. and other concerns.

Water Works

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.

221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*

LEWIS S. LOUER, *Vice-President and General Manager*

New York Office: 904 Longacre Bldg., 42d St. and Broadway

RICHARD E. BROWN, *Eastern Manager*

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Vol. LX. CHICAGO, ILL., OCTOBER 10, 1923 No. 4

College Education

Perennially with the fall opening of our colleges, when for a short time public interest is focused upon them at a maximum, the minds of many of us turn back to our own college days.

We think of the novelty of that first matriculation; of the mysteries before us to be happily unfolded; of the pleasurable anticipation of a four year's work which was to fit us for a happy and "successful" future, more or less explicitly and wrongly pictured in our minds; of the care-freedom of undergraduate life which at the time we neither realized nor appreciated; of the many happinesses and of the same sorrows which even the undergraduate does not escape; of our fanatical admiration for our own chosen profession and our alma mater; of the ideals with which we entered and with which we left college; of the friends made, the knowledge gained and the changes wrought in habits and character. Of these things and many others, we think; but most of all of the peculiar joy of gazing at the future—a future of great and indefinite length, and of nebulous beauty in which the gazer might see what he could.

And as retrospect progresses we look at the succeeding years, at what they have brought, what they have left us and at what those years yet to come appear to hold. Disillusionments there have been aplenty—disappointments, sorrows, griefs. Yet there have been successes also—joys and satisfaction of which as freshmen or as seniors we did not guess. Mist still enshrouds the future but to our better trained eyes its changing lights and shifting masses bring fewer deceptions. Mystery has largely vanished. Some ideals have changed. Much tolerance has been developed.

What today do we think of our "education?" What shall we say to the fellow in his teens who comes to us for advice? To the one who asks

"Shall I study engineering?" or "What branch of engineering shall I study?"

Based upon his own experience and observation the editor would answer somewhat as follows:

A college course comes very near to being worth while for its own sake. That is, it can be made one of those experiences the pleasure and satisfaction of which warrants its cost in time and money; but it is up to you to make it so. Whatsoever course you take, if you take it wisely, will give you an all-round development which you are not likely to secure otherwise within an equal space of time. It will add enormously, while learning is still easy, to that fund of general knowledge on which every man of broad affairs is much dependent, and the possession of which affords so many opportunities for pleasure.

All-round development, of course, requires attention to many things besides books and lectures. Athletics, the society of both sexes, public affairs—all should be indulged in if you want a genuinely broad education. I have known college grinds who graduated with so little knowledge of the ways of men outside a limited circle of distinctly their own kind that they suffered a handicap for years.

Shall you study engineering? That depends upon your ideals and qualifications. If maximum wealth is your aim a commercial career is most likely to bring it, though even there an engineering education will be far from useless. If you are most attracted by the thought of constructive achievement then engineering is good. But never forget that large scale success means hard work. If you wonder what your chances of large scale success in engineering will be, the answer is that there are as many opportunities in engineering as elsewhere, that progress in any field of endeavor depends upon the combination of native and acquired abilities, and that native ability is probably most often to be found in the thing liked best. Consider carefully the fund of experience that you have acquired to date, and so far as possible learn about the kinds of work of which you know the least. Then use your best judgment coupled with the guidance of whoever is best qualified to guide you. Don't let a passing attraction such as the thought of an outdoor life in civil or mining engineering or the pleasure of handling tools and machinery in the mechanical field weigh very heavily with you.

The best field of engineering to select is a matter on which mighty little worth whole advice can be given. In general the qualities that will make good in one will do equally well in another, and the question stands almost wholly as one of personal preference. As a matter of fact very few of us have followed very closely what we had in mind when we went to college.

If you finally decide upon a technical course you will probably find a prescribed curriculum containing subjects for which you do not see the need and at which you will chafe. In this you will be mostly wrong. The faculty has mapped out a course which is far better than any you could plan for yourself, and most of what you don't like has an entirely proper place in it. If it is not perfect, just take it from the old-timers that the perfect doesn't exist, and that success is very largely a matter of getting the most one can out of the imperfect.

Don't throw your ideals aside unless it be for better ones. You may not reach them, but without an ideal to work toward you may be perfectly sure you will never get the best out of yourself. Disillusionments are necessary steps in the development of understanding as the loss of our baby teeth is a step in physical development, but it is bad to try to hasten either. Above all cultivate and keep your self-respect and self-confidence. Many a man superior in every other way has fallen behind simply because he lacked the confidence to carry him ahead after a few mistakes.

New York Water Supplies.—In New York state 86 per cent of the population is now supplied with drinking water from public supplies and 73 per cent with treated or purified water. In 1906 only about 70 per cent of the population was served by public water supplies. From 1885 to 1906, the year supervision of public water supplies began, the death rate from typhoid fever remained practically stationary, averaging about 23 deaths to the 100,000 of population. From 1906 to 1922 there was a marked decrease year by year until the typhoid death rate in the latter year reached the low figure of 3 to the 100,000.

Construction Methods at Laurel Road Dam, Stamford, Conn.

An Ingenious Use of Belt Conveyors for Handling Aggregate and Concrete in Dam Construction

By DAVID BONNER, JR.
Superintendent of Construction, Henry Steers, Inc.

Laurel road dam, now under construction for the Stamford Water Co. at Stamford, Conn., presents an interesting plant layout and a clever use of belt conveyors for handling materials and for lateral distribution of the concrete.

Loading Aggregate on Belt Conveyor.

The structure itself is a gravity section concrete dam of a maximum height of 63 ft., 1,900 ft. long, containing approximately 60,000 cu. yd. of concrete and requiring approximately 40,000 cu. yd. of earth excavation and 10,000 cu. yd. of rock excavation and 75,000 bbl. of cement. The reservoir, which is for storage purposes, will, when completed, be about a mile long and ¾ mile wide and cover an area of 285 acres and hold 2¼ billion gallons.

A preliminary study of the plant layout involved the means of handling earth excavation, rock excavation, back fill, cleaning off the exposed rock and preparing the foundation, digging, crushing and screening the local materials for the aggregate and then mixing the concrete and distributing it to the required place in the dam and the handling and type of the necessary concrete forms.

How the Excavation Was Handled.—Along the downstream face of the dam was laid a 26 ft. gauge track, 400 ft. of it on a heavy trestle, 900 ft. on fill made with the excavated ma-

terial from the trench and 500 ft. on the natural surface of the ground. Upon this track were erected four traveling stiff-leg derricks mounted on 24 in. double flanged wheels. These derricks have 65 ft. booms and are capable of handling 10 tons on a 55 ft. radius.

The excavation is done by a ¾ yd. caterpillar mounted steam shovel loading into steel scale boxes, which the traveling derricks pick up and place in the trestle or ahead to form the road for the traveller track or spoil bank south of the track.

and sounded for seams or soft rock.

The Form Work.—Bulkheads of 2 in. plank and 3x8 studs high enough for two lifts of concrete are then erected and the first lift of concrete placed. After the first lift the face forms come into play. They are made up of steel plates reinforced with angle iron bolted to two steel channels placed back to back on 5 ft. centers. They are assembled in sections 50 ft. long and 8 ft. high and wood walers are used behind the channel iron studs; 1⅛ in. bolts 40 in. long with threads on both ends are set in the

Section of the Aggregate Belt Conveyor.

The back fill is also handled by the traveling derricks, equipped with orange peel buckets.

After the shovels have excavated as close as possible to rock, the mucking gang follows up, cleaning off the rock by hand, the material being handled with scale boxes and the travellers. When uncovered the rock is washed down with a high pressure stream and a fire hose nozzle. The amount of rock to be removed is then determined. Upon the completion of the rock excavation the bottom is again washed down and finally inspected

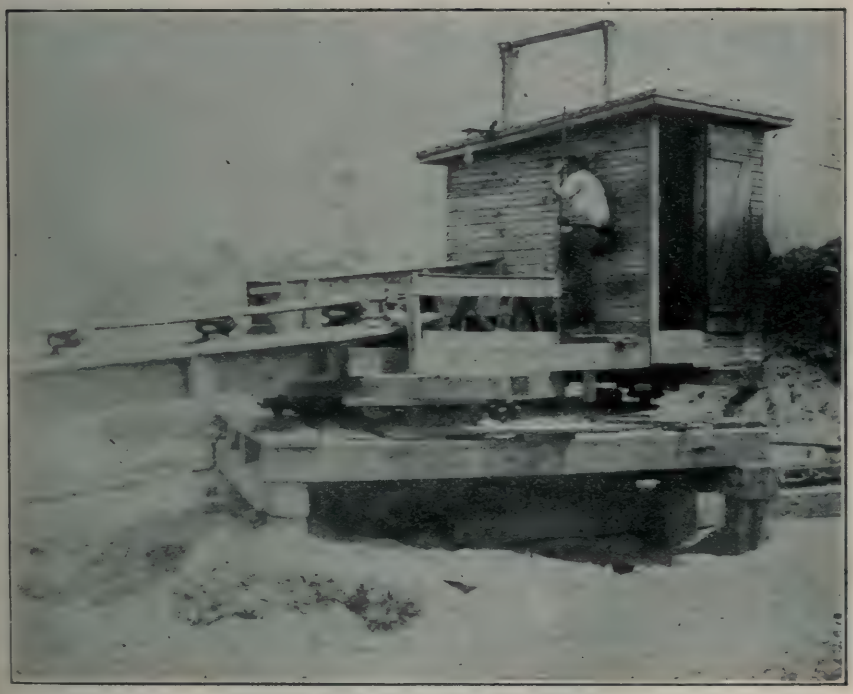
form on 5 ft. centers 18 in. from the top. One end of the bolt has a 1 in. thread and the other 1⅛ in. The 1 in. thread goes inside the form, and on this end is placed a 4x4 washer and a 1 in. nut, which is concreted in. When the form is to be reset the 1⅛ in. bolt is removed, leaving the nut and washer in the concrete. The form is raised by the traveling derricks. A 1 in. bolt 40 in. long is screwed into the nut and the form placed upon it; two 3x8 walers separated by 2 in. wooden blocks are slipped over the bolts, which are then tightened up and

hold the forms rigid on the bottom. The top of the forms are held in line by crossrods and turnbuckles on 10 ft. centers, entirely above the concrete and passing through two 3x10 walers separated by 2 in. blocks.

The concrete in general is poured in 6½ ft. lifts and the sections are 50 ft. long. A form starts in the bottom and is raised until the section is completed, after which the traveling derrick picks it up, carries it ahead and starts it again.

Handling the Concrete Aggregate With Belt Conveyors.—The concrete aggregate material for the dam is local sand and gravel obtained about 1,300 ft. north of the dam, and the pits were stripped of about 2 ft. of overburden. Here a ¾ yd. revolving steam shovel loads the aggregate on a 20 in. belt conveyor through a grill and hopper, rejecting boulders over 8 in. The hopper is mounted on wheels and rolls ahead as the shovel moves.

This conveyor, known as Conveyor A, is 400 ft. long and 20 in wide, and is made up of 18 ft. trussed sections mounted on 2-wheel trucks, the wheels being at right angles to the line of the conveyor and roll on short sections of track laid on planks. The southerly end is mounted on a turntable so that as the shovel completes a cut the conveyor is rolled around radially the amount the shovel has cut and the operation begins again. Conveyor A delivers its load into a hopper at the turntable mounted end and from this point, which is termed the transfer house, Conveyor B, 375 ft. long and 20 in. wide, takes up the load and with a vertical curve on a 20° incline at its southerly end carries it to the gyratory crusher, where the fines are by-passed by a grill and the material above 2 in. is crushed, both the fines and the crusher product being deposited on a 45 ft. inclined belt 24 in. wide, Conveyor C, which takes them up to the rotary screen.



The Transfer House.

From the screen the sand is taken to the storage trestle by Conveyor D, 18 in. wide and 240 ft. long, and the stone by Conveyor E, 20 in. wide and 200 ft. long. The storage trestle is 130 ft. long and 30 ft. high, providing a 2-day storage. The belts take a 20° incline from the screen to the trestle

and there are unloaded into the piles by traveling trippers, stone on the northerly end and sand on the southerly end of the trestle. At the sand end there is an auxiliary conveyor, 16 in. wide and 85 ft. long on which the sand tripper can dump any surplus sand to be taken to a waste pile.

Underneath the storage piles is a timbered tunnel in which run two more belts, one, Conveyor G, under the sand pile, 157 ft. long and 18 in. wide, and Conveyor H, under the stone pile, 251 ft. long and 20 in. wide. These belts are loaded with adjustable chutes in the tunnel and as they emerge from it break into a vertical curve and then into a 20° incline, which brings them to the top of the mixer bins located about 50 ft. from the north face of the dam.

Handling the Aggregate at the Mixing Plant.—Beneath the mixer bins is a platform having about 8 ft. headroom with the batch hopper of the mixer about knee height in the center. From the underneath side of the bins are hung two self-righting buckets, one for sand and one for stone, arranged to trip into the batch hopper. The aggregate is loaded into these buckets by adjustable chutes from the bins and they in turn dump into the batch hopper, where the cement is added. This hopper has four sloping sides and dumps directly into the mixer.

The cement storage of 20,000 bags is located just east of the mixing plant and through the center of it runs Conveyor I, a flat roller belt 20 in. wide and 150 ft. long, which takes the cement bags up to the mixer platform.

The Mixing Plant.—The mixing plant is located 700 ft. from the east end of the dam and 1,200 ft. from the west end. From the mixing plant runs a light trestle parallel with the dam, 5 ft. higher than the coping, with the top cap of the bents cantilevering over the north face about 6 in. Upon this trestle is Conveyor J, running the length of the dam and 20 in. wide.

The mixer dumps into a hoist bucket which is elevated up a steel tower to hopper from which, by means of a short chute, the concrete is loaded on Conveyor J. A traveling tripper

The Storage Trestle.

runs on rails the length of this conveyor and is moved by a line on a winch on one of the tripper pulley shafts as fast as one can walk.

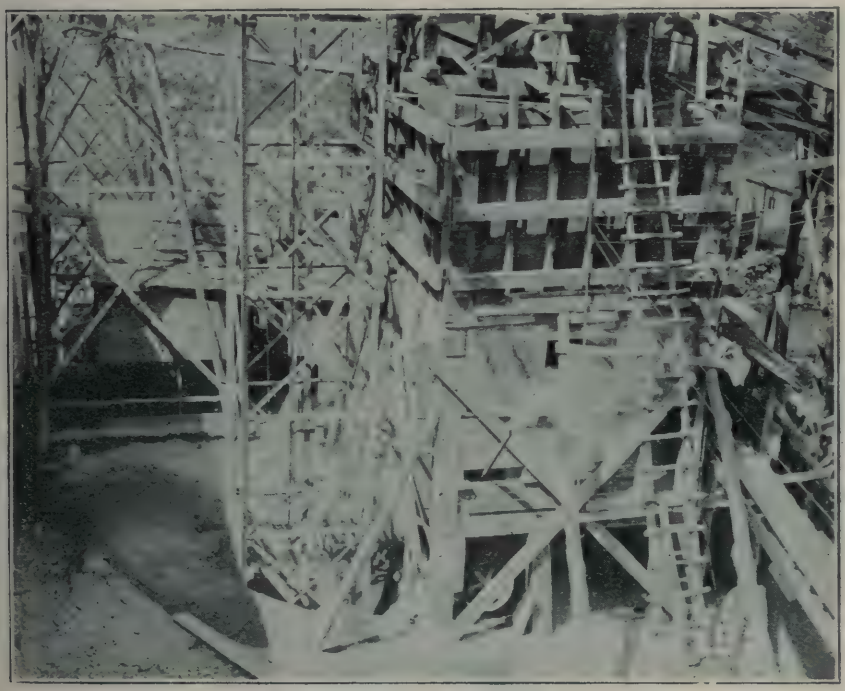
Placing the Concrete.—For the deep sections swivel head chutes are suspended from the tripper and handled by one of the derricks, for the top lifts and the coping flexible drop sections are suspended from the tripper and the tripper is moved up and down the section.

A specially designed scraper on the tripper scrapes the belt clean without harming it. There is no loss of grout whatever on the belt and there is no separation of the aggregate no matter how far it is transported.

The belt conveyors are motor driven, the current being manufactured on the work by a 60 K. W. steam direct connected generator which also furnishes current for lighting. The material conveyors run at a speed of 350 ft. per minute and the concrete conveyor 500 ft. a minute.

The concrete mix is 1:2½:4½. The various blocks, which are in general 6½ ft. thick and 50 ft. long, are dovetailed into one another with keys specially designed to prevent any leakage of water through the dam. Horizontal as well as vertical keys are used, and before a section is started all laitance is washed off the previous section with a fire hose nozzle and a high pressure stream of water. The surface of the previous section is then covered with ½ in. of grout and then the concrete is started. Upon the completion of a section, the horizontal keys weighted with concrete are placed by the traveling derricks, which also place the plums.

The sections are carried up to the under side of the coping, which is placed afterwards, elastite expansion joints are used in the coping, which is 2 in. thick and troweled and marked out in squares with a jointing tool on the top.



The Mixing Plant and Hoist Tower.

The Equipment.—The shovel in the gravel pit is a 14 B. Bucyrus caterpillar mounted. The belt conveyors were made by the Conveying Weigher Co. The compressor is an F. R. I. Ingersoll-Rand, delivering 500 cu. ft. per minute; the drills, D. C. R. 13 Ingersoll-Rand. The generator is a Western Electric and the motors are

General Electric and Westinghouse. The crusher is an 8 in. Bulldog gyratory, made by the Traylor Engineering Co., which also furnished the 4 ft. x 22 ft. screen. The mixer is a 1 yd. Smith tilter. The tower, hoist bucket and hopper were made by Insley. The engines were made by Lambert, Lidgerwood, Mundy and Flory, while Terry and Lambert built the derrick fittings. The shovel in the excavation is a 20 B. Bucyrus caterpillar mounted; the cement bags, before being shipped back to the Nazareth Co., are shaken in a unit sack cleaner.

A. B. Hill of New Haven is the engineer for the Stamford Water Co., Clarence M. Blair is the resident engineer and Harry Stokes his chief inspector.

David Bonner, Jr., is superintendent; Arthur R. Moxter, assistant superintendent; John Fitzpatrick, general superintendent, and H. R. Wheeler, general manager for the contractors, Henry Steers, Inc., of New York.

Depositing Concrete on Belt Conveyor.

Life of Belt Conveyor at St. Louis Water Works

Mr. Leonard A. Day, chief mechanical engineer, St. Louis Water Department, gives in following in the September Journal of the American Water Works Association:

When the boiler room at Bissell's Point Station of the St. Louis Water Works was reconstructed some 8 years ago, a belt conveyor was installed to convey and elevate the coal. It is 215 ft. between centers and elevates the coal 53 ft., starting at a track hopper outside the building and delivering the coal to a group of four bunkers in the boiler room. An average of 70 tons of coal per day have been handled for the past 8 years, 204,400 tons in all, before the belt was replaced. It is made of 5-ply 28 oz. duck, with ⅛ in. rubber cover on the wearing side. It cost $831.60 at $1.89 per foot. This gives a belt cost of 0.4 ct., per ton to move the coal through the distance and to the elevation stated.

Water Waste, Meters and Rates at Baltimore

A Comprehensive Study and Analysis Based on Surveys Covering Present Conditions, Anticipated Results, Financing Problems and Installation Details in a Review Presented to the Engineers' Club of Baltimore, March 28, 1923

By BERNARD SIEMS, C. E.,

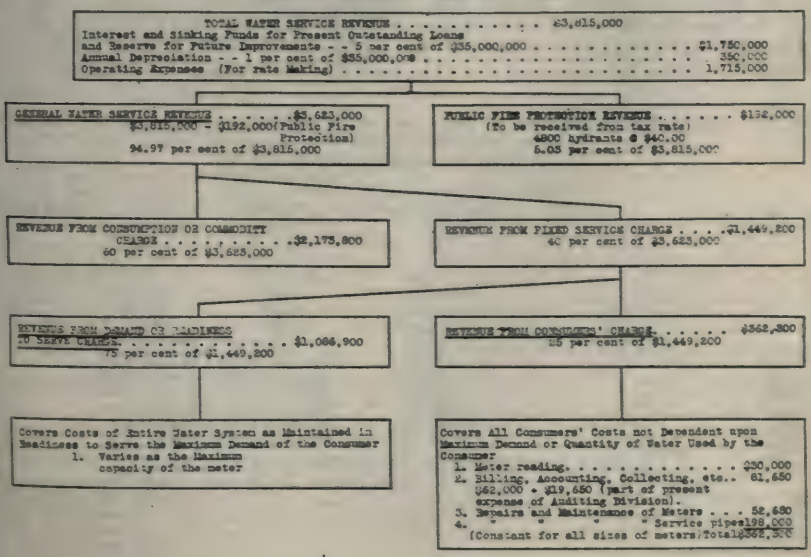
Associate Civil Engineer, Water Department, Baltimore, Md.

Published Serially in Engineering & Contracting

Part II—Meters, Rates, Comparisons and Costs (Continued)

The investment of plant and property of the Water Department of Greater Baltimore is estimated to be $35,000,000.00, and by applying a 5 per cent rate of return to this capital investment an amount of $1,750,000.00 (this amount remains constant regardless of additional capital expenditures) should be secured. As it is the purpose of a municipally owned utility to furnish service to the public at cost, this return which is over and above operating and maintenance cost will cover the annual sinking fund and interest on the present water loan and will, in addition, create a reserve amount to finance future additions or enlargements to the water system. By totaling the fair net return of 5 per cent ($1,750,000.00), an annual depreciation of 1 per cent ($350,000.00) together with operating expenses ($1,433,500.00 plus $281,500.00 for small water mains extensions equals $1,715,000), $3,815,000.00 is obtained as a total service revenue required to make the Water Department self-sustaining. This sum can immediately be divided into that received for public fire protection and that derived from the general water service. The entire cost of public fire protection, based upon a unit charge of $40.00 per fire hydrant, is to be taken from the general tax levy, as it is then paid in proportion to the value of the property protected. The general water service revenue is subdivided into revenue for consumption or commodity charge ($2,173,000.00) and revenue from fixed service charge ($1,449,200); the revenue from fixed

Table XIII—Determination of Recommended Schedule of Rates for the Water Department of Greater Baltimore—January, 1922



service charge is subdivided into revenue from demand or readiness to serve charge ($1,086,900.00) and revenue from consumers' charge ($362,-300.00), (See Table No. 13).

On Table No. 14 are outlined the basic charges—"Recommended Schedule of Rates for the Water Department of the City of Baltimore," submitted to the Water Engineer January, 1922.

Service Charge Endorsed by Commissions.—The fixed service charge principle is slowly but surely receiving universal recognition. The Public Service Commissions of Pennsylvania, New Jersey, Wisconsin, California and perhaps other states have approved rate schedules based upon the fixed service charge. The New York Commission has ruled that "a service charge is a legal and just charge if properly adjusted as to amount".

The Railroad Commission of California in the case of the Spring Valley Water Company, September 3, 1918, stated: "We have given this matter very extensive and careful consideration and have arrived at the conclusion that the sound basis for establishing these rates is that there should be first a service charge based upon the size of the meter, which service charge is to be paid by all consumers, regardless of the amount of water used."

Numerous other references could be given, but those mentioned are sufficient to prove the increasing recognition of the fixed service charge principle as the most rational and logical method yet proposed as a basis for a system of rates.

Under the Water Department's conditions of service, we believe the service charge thoroughly understood will be accepted as a fair and equitable charge.

After determining the service charge, we have given consideration to the charge per one thousand cubic feet of water used, and in this connection have recognized the so-called wholesale principle.

A schedule of rates should equitably and indiscriminately distribute the burden of the expenses of operation, depreciation and fair return on the evaluation of the property. It is obviously unfair and unreasonable for one consumer or class of consumers to pay the cost applicable to any other consumer or class of consumers. In other words, any system of rates charged by public utility should be exactly proportional to the amount of service rendered. This, however, is only possible when the service may be accurately measured by some device, as the equity and fairness of rates by measurement cannot be successfully challenged.

Proposed Rate Schedule.—With these principles in mind, the schedule of rates shown in Table No. 14 was submitted.

Consider a revenue bearing water consumption of over 3,000,000,000 cubic feet per year, the average water service rate will be $0.70 per 1,000 cubic feet. As the cost per unit decreases as the demand increases, a sliding scale of rates has been devised, allowing four classes of consumptions and varying from $0.80 per 1,000 cubic feet for small consumers

Table XIV—Recommended Schedule of Rates for the Water Department of Greater Baltimore, January, 1922

(Bills to Be Rendered Quarterly)

Size of Meter	Annual Fixed Water Service Charge (1)	Maximum Allowable Consumption: Cost (2)	Maximum Allowable Consumption: No. of Cu. Ft. Per Year (3)	An. Minimum Water Service Charge (4) 1 + 2
⅝ in.	$ 6.65	$ 5.85	7,300	$12.50
¾ in.	9.66	8.20	10,250	17.86
1 in.	15.25	15.20	19,000	30.45
1½ in.	22.56	33.96	42,450	56.52
2 in.	88.00	No Allowable Consumption		
3 in.	105.55	No Allowable Consumption		
4 in.	187.25	No Allowable Consumption		
6 in.	415.15	No Allowable Consumption		
8 in.	789.25	No Allowable Consumption		
10 in.	1,150.45	No Allowable Consumption		
12 in.	1,434.25	No Allowable Consumption		

WATER CONSUMPTION OR COMMODITY CHARGE

(Applied in Addition to Annual Minimum Charge or Annual Fixed Charge)

First 60,000 cu. ft. per year	$0.80 per 1,000 cu. ft.
Next 540,000 cu. ft. per year	.60 per 1,000 cu. ft.
Next 4,400,000 cu. ft. per year	.45 per 1,000 cu. ft.
Over 5,000,000 cu. ft. per year	.28 per 1,000 cu. ft.

Table XV—Expenses for Water Department (New Annex Water Companies Not Included) and Collector of Water Rents
(Arranged in Accordance With Municipal Budget)

WATER DEPARTMENT

Salaries

Executive Division	$ 21,796.00	
Auditing Division	19,200.00	
Engineering and Construction Division	96,270.00	
Mechanical Division	40,920.00	
Filtration Division	33,305.00	
	$ 211,491.00	$ 211,491.00

Labor

Engineering and Construction Division	$ 220,000.00	
Mechanical Division	76,175.00	
Filtration Division	51,583.00	
	*$ 347,758.00	$ 347,758.00

*Approximate.

Materials, Etc.

Fuel and Power		$ 226,471.00
Chemicals		78,200.00
Pipes, Fittings, Castings, etc.		115,000.00
Lumber, Rope, Oils, Waste, etc.		16,000.00
Brick, Cement, Sand, Gravel, etc.		3,500.00
Tools, Machinery and Instruments		12,000.00
Miscellaneous		120,000.00
Emergency Fund		300.00
		$1,130,720.00

Funds to Provide for Depreciation of Plants (Designated as New Improvements)

Work in Advance of Improved Paving	$ 176,138.00	
Repairs to Pumping Station	11,078.00	
Booster Pump	1,200.00	
Gravel Washing Machine	2,272.00	
20 M. G. D. Pump Eastern P. S. (Balance, 1921, $10,928.13)	9,513.00	
Auto Trucks	8,000.00	
Lake Aushburton	618.00	
	$ 208,819.00	$ 208,819.00
Total for Water Department (1922)		$1,339,539.00

COLLECTOR OF WATER RENTS

Salaries	$ 39,200.00	
Supplies	7,200.00	
	$ 46,400.00	$ 46,400.00
Total for Water Department and Collector of Water Rents		$1,385,939.00

ANNUAL SINKING FUND AND INTEREST CHARGES FOR 1922 ON WATER LOANS

Interest

1916 Water Loan (1,336,000 at 4 per cent)	$ 53,440.00	
1926 Water Loan (1,000,000 at 4 per cent)	40,000.00	
1943 Water Loan (1,000,000 at 3½ per cent)	35,000.00	
1945 Water Loan (2,000,000 at 3½ per cent)	70,000.00	
1958 Water Loan (5,000,000 at 4 per cent)	200,000.00	
1961 Water Loan (11,000,000 at 5 per cent)	550,000.00	
	$ 948,440.00	$ 948,440.00

Assumed that $15,000,000 loan entirely spent and that interest interest charges of ($750,000—$550,000) $200,000 on $4,000,000 (estimated cost of New Annex Water Companies) provided for from revenue of New Annex Water Companies. No allowance made for operating and maintenance expenses of New Annex Water Companies.

Sinking Fund

1916 Water Loan	$ 116,430.00	
1943 Water Loan	27,000.00	
1945 Water Loan	14,553.75	
1958 Water Loan	38,000.00	
1961 Water Loan	131,000.00	
	$ 326,983.75	$ 326,983.75
Total Annual Interest and Sinking Fund Charges		$1,275,423.75

REVENUE FOR 1922—COLLECTOR OF WATER RENTS
(No Allowance for New Annex Water Companies)

Water Rents: Flat Rate	$1,044,615.19	
Water Rents: Meters	686,025.93	
Water Rents: Plumbing	85,293.69	
Interest on Back Water Rents	5,217.80	
Turn-off and Vacancies	427.50	
Pitometer Survey	9,055.82	
Total Revenue for 1922	$1,830,635.93	$1,830,655.93

DEFICIT FOR 1922—WATER AND COLLECTOR OF WATER RENTS DEPARTMENTS

Salaries and Expenses	$1,385,939.00	
Interest and Sinking Funds on Water Loans	1,275,423.75	
Total Expenses	$2,661,362.75	$2,661,362.75
Total Revenue for 1922		1,830,635.93
Total Deficit for 1922		$ 830,726.82

to $0.28 for those using over 5,000,000 cubic feet per year. Domestic services (⅝ in. meter) are to be charged a minimum water service charge of $12.50 ($3.125 quarterly), allowing a yearly consumption of 7,300 cubic feet equivalent to the use of thirty gallons per capita per day which is sufficient for cleanliness and for furnishing water for drinking and culinary purposes, etc. See Table No. 14 for annual minimum water service charge and maximum allowable consumption for ¾ in., 1 in. and 1½ in. metered water supply services.

Detail of Expenses.—In Table No. 15 are shown the expenses for the Water Department (New Annex Water Companies not included) and collector of water rents—Year 1922 (arranged in accordance with Municipal Budget); and in Table No. 16, are shown the Estimated Total Operating Expenses of the Water Department—Year 1923 (based upon new classification of accounts now in effect). These operating expenses were used for "Recommended Schedule of Rates," "The Financial Status of the Water Department as Affected by Metering" and the Development of the Gunpowder-Patapsco Supplies.

Table XVI—Estimated Total Operating Expenses of the Water Department—Year of 1923
(Based Upon New Classification of Accounts Now in Effect)

1.	GENERAL EXPENSES			$ 136,800.00
11.	*Administrative Expenses*		$ 27,500.00	
	1. Pay and expenses of Executive Division employes	$23,400.00		
	2. Office supplies and expenses	500.00		
	3. Executive Division stationery, printing, etc.	1,500.00		
	4. Executive Division miscellaneous expenses	100.00		
	5. Executive Division automobile expenses	2,000.00		
12-A.	*Accounting and Commercial Expenses*		$ 32,200.00	
	1. Pay and expenses of Auditing Division employes	$26,600.00		
	2. Auditing Division office supplies and expenses	1,000.00		
	3. Auditing Division postage, telephone and telegraph	500.00		
	4. Auditing Division stationery, printing and advertising	2,000.00		
	5. Auditing Division miscellaneous expenses	100.00		
	6. Auditing Division paymaster automobile expenses	2,000.00		
12-B.	*Accounting and Commercial Expenses—Engineering and Construction Division*		$ 11,500.00	
	1. Reading of meters	$11,500.00		
	2. Meter bills			
12-C.	*Accounting and Commercial Expenses—Collector of Water Rents*		$ 55,600.00	
15.	*Injuries and Damages*		$ 10,000.00	
2 and 3.	OPERATING AND MAINTENANCE EXPENSES			$1,296,660.00
21-A.	*Operating Management Expenses—Filtration Division*		$ 18,600.00	
	1. Pay and expenses of operating management employes	$12,300.00		
	2. Office supplies and expenses	2,000.00		
	3. Automobile expenses	1,500.00		
	4. Storeroom and machine shop expenses	1,800.00		
	5. Miscellaneous expenses	1,000.00		
21-B.	*Operating Management Expenses—Mechanical Division*		$ 12,600.00	
	1. Pay and expenses of operating management employes	$ 9,000.00		
	2. Office supplies and expenses	1,000.00		
	3. Automobile expenses	1,600.00		
	4. Miscellaneous expenses	1,000.00		
21-C.	*Operating Management Expenses Engineering and Construction Division*		$151,250.00	
	1. Pay and expenses of operating management employes—Executive Subdivision	$10,550.00		
	2. Pay and expenses of operating manage-			

	ment employes—Cost Anal. Subdivision	8,480.00	
	3. Pay and expenses of operating management employes—Construction Subdivision	10,800.00	
	4. Pay and expenses of operating management employes—Maintenance Subdiv.	5,950.00	
	5. Pay and expenses of operating management employes—Conservation Subdiv.	12,350.00	
	6. Pay and expenses of operating management employes—Meter Account Subdiv.	6,400.00	
	7. Pay and expenses of operating management employes—Clerical Subdivision	12,070.00	
	8. Office supplies and expenses	10,000.00	
	9. Engineering salaries and expenses	13,750.00	
	10. Storeroom and yard expenses	30,400.00	
	11. Miscellaneous expenses	8,500.00	
	12. Miscellaneous tools, foreman's field equipment and appliances	22,000.00	
22-A & 32-A.	*Collecting System—Gunpowder Supply*		$ 18,400.00
22-B & 32-B.	*Collecting System—Patapsco Supply*		3,000.00
22-C & 32-C.	*Collecting System—Jones Falls Supply*		1,420.00
23-A & 33-A.	*Purification Expenses—Montebello Filter plant*		243,850.00
	1. Heating plant	$ 3,300.00	
	2. Lighting system	1,250.00	
	3. Laboratory	10,750.00	
	4. Pumping (Low Service Pumping Station)	95,850.00	
	5. Chemicals	85,000.00	
	6. Chemical handling	4,550.00	
	7. Chemical mixing and control	17,700.00	
	8. Filters	10,550.00	
	9. Mixing basin	1,400.00	
	10. Coagulating basin	300.00	
	11. Clear water basin	500.00	
	12. Wash water equipment	700.00	
	13. Miscellaneous	12,000.00	
23-B & 33-B.	*Montbello Filter Grounds*		$ 18,050.00
	1. Roads	$ 800.00	
	2. Miscellaneous structures	4,000.00	
	3. Outside piping and drains	100.00	
	4. Sewage disposal plant	300.00	
	5. Grounds	11,300.00	
	6. Horses and wagons	1,550.00	
23-C & 33-C.	*Purification Expenses—Avalon Filter Plant*		$ 3,850.00
24-A & 34-A.	*Eastern (Middle Service) Pumping Station*		$ 55,000.00
	Electric power	$41,000.00	
	Oil, grease and waste	100.00	
	Coal	850.00	
	Labor (attendants)	9,000.00	
	Labor (maintenance)	3,190.00	
	Material (operating)	240.00	
	Material (maintenance)	1,060.00	
	Rubber goods	20.00	
	Miscellaneous	10.00	
24-B & 34-B.	*Mt. Royal (Western Middle Service) Pumping Station*		$107,870.00
	Coal	$47,600.00	
	Oil and grease	460.00	
	Waste	600.00	
	Packing	350.00	
	Rubber goods	160.00	
	Labor (attendants)	17,980.00	
	Labor (operating)	29,800.00	
	Material (operating)	3,190.00	
	Material (maintenance)	7,600.00	
	Miscellaneous	130.00	
24-C & 34-C.	*Druid (High Service) Pumping Station*		$ 30,910.00
	Electric power	$18,200.00	
	Labor (attendants)	8,940.00	
	Labor (operating)	2,360.00	
	Material (operating)	150.00	
	Material (maintenance)	710.00	
	Coal	430.00	
	Oil and waste	20.00	
	Miscellaneous	100.00	
24-D & 34-D.	*Belair Road (High Service) Pumping Station*		$ 25,000.00
24-E to 24-K. 34-E to 34-K.	*New Annex Pumping Stations (Avalon, Catonsville, Hillsdale, Mt. Washington, Towson and Curtis Bay)*		$100,000.00
24 & 36.	*Distribution Balancing and Storage Reservoirs, Tanks and Standpipes*		$ 15,140.00
	1. Ashburton Reservoir (W. M. S.)	$ 1,530.00	
	2. Guilford Reservoir (E. M. S.)	3,050.00	
	3. Pimlico Reservoir (H. S. P. S. Suction Reservoir)	50.00	
	4. Pikesville Reservoir	2,000.00	
	5. Druid Lake	1,280.00	
	7. Lake Clifton	650.00	
	8. Hampden Reservoir	3,380.00	

	9. Roland Park Standpipe		200.00	
	10. Arlington Standpipe		1,000.00	
	11. New Annex Reservoirs and Standpipes (Highlandtown, L. S.), (Towson, H. S.), (Catonsville, U. S.) and (Towson and Catonsville Standpipes).		2,000.00	
27-A to 27-C. } 37-A to 37-C. }				cut cut
	Distribution System			$452,720.00
	Construction Subdivision	$144,000.00		
	Maintenance Subdivision		240,000.00	
	Meter Account Subdivision		18,720.00	
	Conservation Subdivision		50,000.00	
28.	*Pitometer Survey*			$ 22,000.00
	Fire flow tests, valve surveys, pitometer surveys, etc.	$ 7,000.00		
	House inspection		15,000.00	
31.	*Miscellaneous Expenses*			$ 17,000.00
	Miscellaneous expenses	$10,000.00		
	Charges for water used at Water Department properties		7,000.00	
	TOTAL OPERATING EXPENSES			$1,433,460.00

Part III—Financing the Cost of Installing Meters

It is the present trend of public service and railroad commissions having state supervision of public utilities to consider the meter as an integral and necessary appurtenance of the water distribution system, and as such, should be owned and consequently purchased by the utility.

Some Court Rulings.—This present thought is in marked contrast with some of the earlier commission and court ruling on this subject. For example, in 1903 the Wisconsin Supreme Court held that the water meter is not so exclusively for the benefit of the one furnishing the water that the duty to furnish it (the meter) cannot be imposed upon the consumer. In New York it has been held that a statute authorizing the commission of public work to place a water meter in the building to which water is furnished for business consumption, and making its cost a lien upon the premises, is not unconstitutional.

In the second class and more modern rulings, the Indiana, Wisconsin, Illinois and Montana commissions have generally held that the company or municipality should bear the cost of the meter and this is the present view of the weight of authority (Wyman on Public Service Corporation, P. 1251). The Kansas Public Utilities Commission held in 1915 that a rule requiring patrons to purchase their water meters from the Leavenworth Water Company is reasonable, provided the company buys them to the best advantage and sells them without profit and the meters are such as to give the best service at the least expense; and a ruling requiring consumers to pay for valves, pipe and stop box was held reasonable.

Payment for Meter by Consumer.—In the investigation of water supply improvement for Greater Baltimore (December, 1919) the writer suggested that the consumers be required to pay for the meter, the reason for this being that the Water Department does not own the service connection of the individual consumer. This is his own property or rather is considered as integral with the property itself. This connection is installed for the property and is considered a direct benefit, and a direct charge is applied both for the original cost and all subsequent repairs. The department has reserved the right to make all repairs on the water supply service between the water main in the highway and the curb line at the property's expense, to insure uniformity in the materials used and to prevent unauthorized parties from handling the valves on the department distribution system. From the curb stop in, all repairs are made at the consumer's expense by the owner's plumber.

With such a system effective it would introduce a discordant element for the individual meter to be owned by the department and to be connected at either end with pipe owned by the consumer, for petty complications could arise as to repairs. Under the circumstances it was considered best for the department's interest that the consumer own the meter and be responsible for its maintenance, as with water supply services. Where the Water Department applies a fixed service charge, it

should own and maintain both the water supply service and the meter; this seems to be in harmony with modern trend of thought.

The city is to obtain authority from the legislature, if such authority is lacked, to issue short term notes with a life of two and one-half years at the rate of $200,000 a year, which sum is sufficient to finance a year's work on the installation of 10,000 water meters. This money is to be returned in eight payments by the consumer, in a period of two years, in payment for the cost of the installation plus the interest requirements for the period of two and one-half years. This idea was not worked out to the extreme details, but as suggested is a practicable scheme for metering the city without any additional expenditure of capital by the department.

Another Method of Financing.—Another scheme for financing this improvement is for the applicant for water service in the case of a new water supply service, to pay for the cost of the new water service and meter when applying for water service. This cost would be ascertained from the department records for work of this kind and would represent an average cost. The money paid for the installation of the water service would not be refunded, but the money paid for the meter and its installation would be refunded in the following way:

In the report entitled "Recommended Schedule of Rates for the Water Department of the City of Baltimore," dated January, 1922, the fixed service rate per year was ascertained to be $6.65 a year for a ⅝ in. meter, and $9.66 a year for a ¾ in. meter. The average cost of installing the water meter which the consumer advances to the city at the time an application is made for new water service is to be returned by the department not charging the fixed service charge for a period sufficient to extinguish the debt, allowing the applicant interest at the rate of four per cent a year. This would also be applicable in the case of the consumer who has a water supply service; he would pay only for the cost of the installation of the meter on his existing water supply service pipe and the money would be refunded in the same way. The conditions would be somewhat analogous to our present policy.

To operate the department as a public utility and amenable to the regulations of the Public Service Commission, it is my opinion that neither of these previous suggestions

Table XVII—Annual and Cumulative Savings Effected by Metering.

Annual and Cumulative Savings Effected by Metering														
Year	Average Daily Gallons	Saving in Cost of Pumping and Filtering		Saving in Annual Increase and Depreciation Charges		Increase in Operating Expenses		Net Saving in Operating Expenses		Saving in Capital Outlay		Grand Total Saving	
		Annual	Cumulative	Total	Cumulative	Annual	Cumulative	Annual	Cumulative	Annual	Cumulative	Annual	Cumulative
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8) 2+4-6	(9) 3+5-7	(10)	(11)	(12) 8+10	(13) 9+11
		$	$	$	$	$	$	$	$	$	$	$	$
1922	1.66	17,239	17,239	- 21,600	- 21,600	3,750	3,750	- 8,111	- 8,111	- 270,000	- 270,000	- 278,111	- 278,111
1923	3.46	36,606	53,845	- 22,850	- 44,450	3,750	7,500	10,004	1,893	- 296,000	- 566,000	- 284,994	- 563,106
1924	5.43	48,140	101,985	126,615	82,165	3,750	11,250	171,005	172,900	2,494,303	2,129,303	2,665,308	2,302,203
1925	7.78	60,565	162,550	255,699	335,864	3,750	15,000	310,484	483,384	5,234,788	7,364,091	5,545,242	7,847,445
1926	10.28	73,947	236,397	2,010	337,874	3,750	18,750	72,107	555,461	202,192	7,566,283	274,299	8,121,744
1927	13.01	88,534	324,940	- 14,810	323,064	3,750	22,500	69,974	625,435	- 134,205	7,432,078	- 64,231	8,057,513
1928	15.98	100,828	425,768	- 4,572	318,492	3,750	26,250	92,706	718,141	74,583	7,506,661	167,289	8,224,772
1929	19.21	114,979	540,747	- 21,600	297,092	3,750	30,000	89,629	807,770	- 270,000	7,236,651	- 180,371	8,044,401
1930	22.68	128,440	669,187	31,780	328,872	3,750	33,750	156,430	964,200	797,500	8,034,251	954,030	8,998,451
1931	26.40	143,642	812,829	- 5,655	323,157	3,750	37,500	134,237	1,098,437	48,892	8,083,129	183,135	9,181,566
1932	30.33	152,231	965,060	11,095	334,252	000	37,500	163,326	1,261,763	221,896	8,305,025	385,222	9,566,788
1933	34.55	160,914	1,125,974	- 96,041	238,211	000	37,500	64,873	1,326,636	-1,920,819	6,384,206	-1,855,946	7,710,842
1934	39.18	164,367	1,290,341	-275,552	- 36,341	000	37,500	-109,188	1,217,451	-6,471,044	913,162	-5,580,229	2,130,613
1935	30.14	181,120	1,471,461	- 19,392	- 54,733	000	37,500	161,734	1,379,185	- 387,852	525,310	- 226,098	1,904,515
1936	31.12	191,731	1,663,192	- 5,334	- 60,067	000	37,500	186,397	1,565,582	- 106,672	418,638	79,725	1,984,240
1937	32.06	203,024	1,866,216	- 9,292	- 69,359	000	37,500	193,732	1,759,314	- 185,944	232,694	7,788	1,992,128
1938	33.09	215,916	2,080,132	- 8,577	- 77,936	000	37,500	208,839	1,964,653	- 171,534	61,160	33,605	2,025,953
1939	34.10	224,909	2,305,041	- 2,999	- 80,935	000	37,500	221,910	2,186,563	- 59,972	1,188	161,938	2,187,871
1940	35.12	238,783	2,540,824	000	- 80,935	000	37,500	238,783	2,422,346	000	1,188	238,783	2,423,534
1941	36.17	246,360	2,787,814	- 8,129	- 89,064	000	37,500	238,231	2,660,577	- 162,576	- 161,388	75,655	2,500,309
1942	37.20	251,321	3,039,508	- 8,887	- 97,951	000	37,500	242,434	2,903,011	- 177,736	- 339,004	64,698	2,565,007
1943	38.20	257,675	3,296,180	000	- 97,951	000	37,500	257,675	3,160,686	000	- 339,004	257,675	2,822,682
1944	39.21	264,924	3,561,104	3,932	- 94,019	000	37,500	268,856	3,429,542	78,648	- 260,356	347,504	3,170,186
1945	40.49	273,513	3,834,617	000	- 94,019	000	37,500	273,513	3,705,098	000	- 260,356	273,513	3,445,499
1946	41.09	276,710	4,111,327	- 4,473	- 98,492	000	37,500	272,237	3,978,292	- 99,464	- 349,820	172,773	3,628,472
1947	42.11	285,182	4,396,509	000	- 98,492	000	37,500	285,182	4,258,474	000	- 349,820	285,182	3,909,654
1948	43.49	290,555	4,685,064	216,046	117,574	000	37,500	506,621	4,755,095	4,521,314	3,971,494	4,827,935	8,727,591
1949	44.60	295,971	4,981,035	- 11,369	106,205	000	37,500	284,602	5,048,597	- 227,371	3,744,125	57,231	8,792,822
1950	45.40	301,102	5,282,137	000	106,205	000	37,500	301,902	5,351,599	000	3,744,125	301,902	9,096,724
1951	46.60	307,666	5,590,603	000	106,205	000	37,500	307,666	5,659,265	000	3,744,125	307,666	9,404,390
1952	48.00	317,959	5,908,562	000	106,205	000	37,500	317,959	5,977,224	000	3,744,125	317,959	9,722,349
1953	48.29	318,828	6,227,390	000	106,205	000	37,500	318,828	6,296,052	000	3,744,125	318,828	10,041,177
1954	48.80	318,693	6,546,083	- 5,932	102,273	000	37,500	314,761	6,610,813	- 78,648	3,665,477	236,113	10,277,290
1955	50.20	329,653	6,875,736	000	102,273	000	37,500	329,653	6,940,466	000	3,665,477	329,653	10,606,943
1956	51.50	337,508	7,213,244	497,339	599,612	000	37,500	835,047	7,775,513	9,980,780	13,646,257	10,785,827	21,391,770
1957	52.50	343,158	7,556,402	000	599,612	000	37,500	343,158	8,118,671	000	13,646,257	343,158	21,735,928
1958	53.37	349,035	7,905,437	000	599,612	000	37,500	349,035	8,467,706	000	13,646,257	349,035	22,084,963
1959	54.50	355,471	8,261,108	-230,800	369,012	000	37,500	124,671	8,592,379	-4,616,000	9,000,257	-4,491,129	17,592,636
1960	55.81	362,761	8,623,869	000	369,012	000	37,500	362,761	8,955,368	000	9,000,257	362,761	17,956,618

would be applicable. The Pennsylvania Public Service Commission has ruled that where a fixed service charge is applied the applicant is not properly chargeable with the cost of the service or meter. If this ruling is applicable here it would add difficulties to any scheme for intelligently financing the installation of meters. As previously stated the various service commissions have made conflicting rulings on this subject, but the tendency is to require the utility to own all its means of distribution, and the Maryland commission has taken this view with respect to the public utilities of this state—the Consolidated Gas Electric Light & Power Company and the Baltimore County Water & Electric Company (now municipally owned), being required to own the meters which were installed by the utility at the time of the installation of the service. The increase in capital investment is compensated by the increased portional return on the larger investment.

The proposed water rates are so devised that a surplus would be created to pay the sinking fund and interest on the various water loans outstanding; also a surplus over this necessary amount which was to accumulate annually at four per cent interest and finance, without more bond issues, the various necessary additions to the department impounding and distribution systems as recommended by Messrs. Hill & Fuertes in their final report dated June 23, 1920. This sum for the first year would be approximately $346,500 with interest, which, either partially or wholly divided from its intended purpose would be available for installing water meters.

At the time these various additions were recommended by Messrs. Hill & Fuertes, estimates were made on the basis of a completely metered city. It is doubted if these improvements can be delayed and the deficiency in the accumulated revenue in 1930, when the first addition is recommended, could be met by a bond issue—for the entire amount if a ten-year schedule is adopted, and for but a part of the sum with a twenty-year schedule. Assuming the adoption of the rate schedule, it would be a questionable policy for the department to use the accumulated surplus for any purpose other than previously stated, and although this method of financing meter installations would be available, it is obvious that the disadvantages outweigh any advantage.

Financing by Issuance of Bonds.—There remains the expedient of another loan, with a life of twenty years—the estimated useful life of a water meter. By this method the entire city could be metered in as short a period as is deemed desirable, considering the possibility of inflating the price of small water meters by the intensive demand, and the most efficient rate of installation.

This, while without doubt the best method for financing the improvement, would be unquestionably the hardest to adopt, as the bond issue must be voted upon and the possibility of its approval is negligible, as there is an overwhelming number of small property owners who now pay small water rents and who do not desire to pay the higher water rates of the metered system.

As the Water Department is unquestionably a public utility and the Rice Bill (House Bill No. 420, Chapter No. 289) which was passed by the legislature and approved by the governor, places the department in a measure under the Public Service

Table XVIII—Cost of Pumping and Filtering

	HIGH		MIDDLE			
	East	West	East	West	South	Low
Montebello						
Chemicals	$ 2.62	$ 2.62	$ 2.62	$ 2.62	$ 2.62	$ 2.62
Pumping	2.95	2.95	2.95	2.95	2.95	2.95
Eastern Pumping Station	12.59	.....	12.59	.....	.....	.....
Mt. Royal Pumping Station	.....	5.18	.....	5.18	.....	.....
Curtis Bay Pumping Station	.....	.....	.....	.....	12.00	.....
Belair Road Pumping Station	16.00	.....	.....	.....	.....	.....
Druid Pumping Station	.....	17.81	.....	.....	.....	.....
TOTAL	$34.16	$28.56	$18.16	$10.75	$17.57	$5.57

The above mentioned accounts cover only the cost of chemicals at the filter plant and the cost of coal and electricity at the pumping stations. They do not include maintenance, attendance, material, or any other miscellaneous costs making up the actual operating expense.

From this it may be seen that the saving, as tabulated in table is extremely conservative.

Commission, it appears to be the wisest policy to allow this commission to make a survey of the whole system of rates for Baltimore and the surrounding counties, as it is apparent that the artificial divisions now existing must be eliminated and the entire area considered as one from the standpoint of water supply. The creation of a commission to manage the whole ysstem, considering the whole territory as a metropolitan district, would be advisable.

If a scheme for financing by the issuance of bonds is adopted, it cannot be too strongly emphasized that the life of these bonds should not exceed the useful life of the water meter. The working parts being subject to renewal and repair are properly chargeable to operating maintenance, but the casing being of necessity exposed to frost and to other adverse influences, should be considered the basis of the life of the meter from the viewpoint of the amortization of bonds.

This life is the average obtained from the experience of various large public and private water corporations, and is that recommended in the "Final Report of the Committee on Depreciation of the American Water Works Association." From this consideration it logically follows that the bonds issued for this purpose should be for a period not longer than twenty years.

Money rate and bond yields mutually influence each other since both represent a return for the use of capital, but since the term "money rates" is applied only to loans for short periods, changes in these rates are chiefly dependent upon transitory conditions, while bond yields are based upon conditions of a more permanent nature.

This is especially pertinent at the present time when well secured bonds are selling at a yield of about 4.35 per cent, although there is every indication that we are entering a period of minor inflation. Money rates are increasing, as is evidenced by the Federal Reserve Bank increasing its rediscount rate, and it follows that the yield on bonds will likewise increase, which will be reflected in the higher rates the municipality will have to pay on its bonds to attract buyers. If bonds must be issued for the installation of water meters, which is probable, then they should

Table XIX—Operating Expenses, Cost of Pumping and Filtering.

OPERATING EXPENSES — COST OF PUMPING AND FILTERING																	
	UNMETERED							METERED IN 10 YEARS									
	HIGH		MIDDLE					HIGH		MIDDLE							
YEAR	EAST	WEST	EAST	WEST	SOUTH	LOW	TOTAL	EAST	WEST	EAST	WEST	SOUTH	LOW	TOTAL
1921	$15.20	$159.22	$175.61	$225.75	$12.30	$309.52	$897.60	$15.20	$159.22	$175.61	$225.75	$12.30	$309.52	$897.60
22	16.09	168.39	177.57	235.30	13.18	315.48	926.01	11.99	125.86	177.57	235.30	13.18	315.48	878.78
23	17.32	180.73	179.53	244.86	14.06	321.95	958.43	8.54	89.22	179.53	244.86	14.06	321.96	858.14
24	18.28	191.27	181.49	254.39	15.08	328.13	988.44	8.92	92.13	170.74	242.95	13.88	328.13	856.75
25	19.68	205.69	183.45	263.93	15.99	335.02	1023.76	9.29	97.19	167.20	236.43	13.70	335.02	857.83
26	21.58	220.43	188.41	273.46	17.04	342.03	1059.47	9.70	101.45	164.69	225.75	13.53	342.03	857.15
27	22.58	236.22	187.37	283.03	18.27	349.19	1096.64	10.11	106.73	160.72	215.00	13.38	349.19	854.18
28	24.29	254.13	189.34	292.57	19.33	356.64	1136.30	10.52	110.13	161.82	216.46	13.44	347.70	848.07
29	26.23	276.12	191.30	302.12	20.38	364.53	1180.68	10.97	114.64	162.93	217.95	13.53	346.67	845.67
30	28.18	294.94	193.26	311.66	21.61	372.54	1222.19	11.41	119.30	164.06	219.42	13.62	342.49	870.30
31	30.33	317.36	195.22	321.21	22.84	380.88	1267.84	11.85	124.04	165.18	220.91	13.70	338.62	874.30
32	32.52	340.66	197.18	330.76	24.00	389.38	1314.53	12.16	127.32	169.56	228.76	14.07	347.59	897.46
33	34.95	365.51	199.14	340.30	24.60	398.17	1362.67	12.50	130.78	174.15	232.91	14.46	357.01	921.81
34	38.37	376.34	201.10	349.85	25.62	407.45	1397.35	12.84	134.49	179.11	239.54	14.86	367.19	947.03
35	40.45	423.32	203.07	359.39	27.80	416.96	1470.90	13.22	138.26	184.14	246.27	15.29	377.50	974.68
36	43.42	454.36	205.03	368.94	29.08	426.86	1527.69	13.60	142.20	189.37	253.27	15.73	388.23	1002.40
37	46.73	488.92	206.99	378.49	30.31	437.26	1588.70	14.01	146.46	195.06	260.87	16.20	399.88	1032.47
38	49.74	520.45	208.95	388.03	31.83	447.15	1645.95	14.38	150.34	200.23	267.80	16.62	410.51	1059.88
39	52.85	552.89	210.91	397.58	32.68	457.22	1704.13	14.76	154.31	205.53	274.90	17.06	421.38	1087.94
40	55.89	584.54	212.87	407.12	33.91	467.12	1761.45	15.15	158.22	210.73	281.85	17.50	432.04	1115.47
41	58.79	615.15	214.83	416.67	35.14	476.85	1817.43	15.51	162.05	215.83	288.67	17.92	442.49	1142.47
42	62.28	628.21	216.79	426.22	36.19	487.33	1855.33	15.85	165.51	220.43	294.82	18.31	451.92	1166.84
43	61.66	645.26	218.76	435.76	37.25	499.63	1898.32	16.19	169.13	225.26	301.27	18.71	461.80	1192.36
44	63.30	664.40	220.72	445.31	38.30	510.77	1943.80	16.53	172.62	229.91	307.49	19.10	471.33	1216.98
45	65.42	684.33	222.68	454.86	39.36	522.47	1989.11	16.84	175.84	234.21	313.26	19.48	480.18	1239.78
46	68.30	693.69	224.64	464.40	40.41	533.02	2022.49	17.18	179.33	238.86	319.48	19.84	489.69	1264.38
47	67.94	711.14	226.60	473.95	41.38	544.75	2065.76	17.52	182.98	243.69	325.93	20.24	499.58	1289.92
48	69.33	727.79	228.56	483.49	42.34	557.00	2108.73	17.83	186.18	247.99	331.69	20.59	508.41	1312.69
49	70.78	740.82	230.52	493.04	43.22	568.14	2145.49	18.14	189.30	252.13	337.22	20.94	516.86	1334.61
50	72.38	757.33	232.48	502.58	44.10	579.28	2188.16	18.48	193.34	257.13	343.89	21.37	527.12	1361.32
51	73.88	769.48	234.45	512.13	44.89	590.42	2224.90	18.75	196.01	261.09	349.19	21.70	535.24	1381.98
52	75.97	794.52	236.41	521.68	45.68	600.45	2276.01	19.06	199.12	266.23	354.72	22.06	543.71	1405.39
53	76.14	796.65	238.37	531.22	46.30	611.59	2300.17	19.37	202.35	269.83	360.48	22.40	552.54	1426.47
54	76.31	798.48	240.33	540.77	46.91	621.61	2324.41	19.71	205.83	274.18	366.70	22.79	562.03	1451.24
55	79.05	826.86	242.29	550.31	47.64	632.20	2378.15	20.02	209.20	278.67	372.69	23.18	571.26	1474.98
56	80.78	844.69	244.25	559.86	48.37	642.22	2419.74	20.29	212.05	282.46	377.76	23.47	579.02	1496.06
57	82.22	860.06	246.21	569.41	48.37	652.80	2459.07	20.62	215.29	286.76	384.59	23.82	587.82	1518.91
58	83.69	874.59	248.17	578.95	48.76	662.83	2496.99	20.91	218.61	291.07	389.28	24.18	596.64	1540.68
59	85.16	891.04	250.14	588.50	49.02	673.97	2537.83	21.21	221.74	295.37	396.04	24.53	606.60	1563.59
60	86.70	907.12	252.10	598.04	49.20	685.11	2578.27	21.49	224.71	299.53	400.54	24.86	613.42	1584.25

be issued at once to take advantage of the favorable interest rate.

The summation of the questions of a bond issue for financing the installation of water meters is:

1. The bond should not be for a greater period than the useful life of the water meter—say, twenty years.

2. They should not be issued in a yearly amount greater than the actual pro rated yearly cost of the entire improvement.

3. The bonds should mature serially; i. e., the bond issued for the first year's work should mature in twenty years, followed yearly by the bonds issued in the successive following years.

4. Any proposed schedule of rates should create a sinking fund for their amortization.

The foregoing discussion has dealt exclusively with the financial operation of the Water Department. The essential difference between this department and other municipal operations must next be considered and such distinctions judged from the viewpoint of the advisability of their operations as self-supporting financial units.

Municipal Utilities.—Second in importance to a supply of potable water is an efficient system for the disposal of sewage, that is, the Sewer Division, Highways Engineer Department. Any charge levied on the individual consumer to make this department self-supporting would partake in general of the characteristics of a flat rate. If a flat rate is to be levied, a far more convenient method of payment would be by including this charge in the tax rate proper, which is, in fact, the present method of supporting the sewerage system. As there is, however, a direct and unvarying relation between the amount of water consumed on each premises and the amount of waste water issuing therefrom, a revenue bearing system for sewerage service could be constructed, based upon the metered water consumption of the property. This carries us back to one of the first statements made in this paper—it is absolutely essential that a city be one hundred per cent metered.

The disposal of garbage and ashes is another municipal function. As it would not be feasible to weigh or otherwise make a definite unit charge for each cubic foot of matter removed,

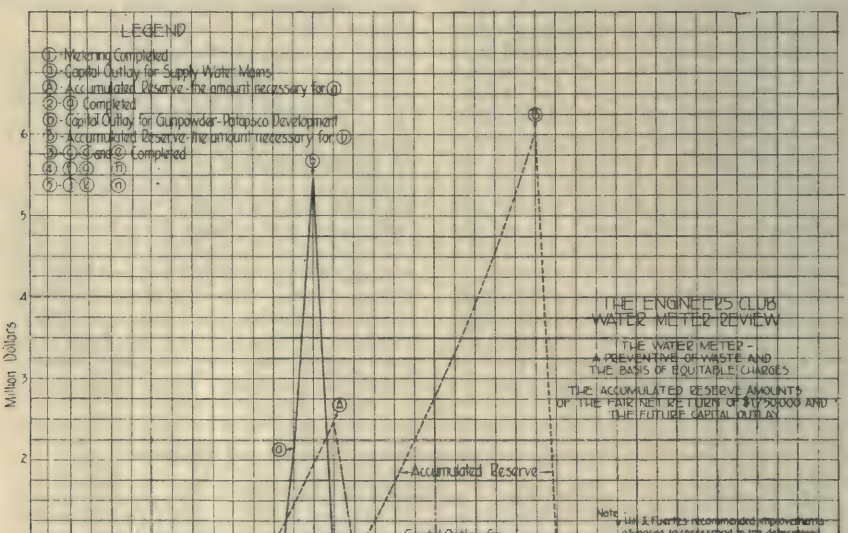


Fig. 1

a flat rate charge would again have to be assessed, and the general tax levy is the proper place for such charges to be made. The Street Cleaning Department—responsible for the cleanliness of all thoroughfares—is another city unit which serves every citizen, but the individual property owner cannot be expected to pay for the benefit derived according to the front footage of his property. The expenses of this department should therefore be taken from the general tax levy. The maintenance of the municipal hospital and almshouse indirectly benefits each and every citizen, but as the patient is rendered free attention the charge must be distributed over the entire population, that is, taken from the tax rate. The various activities of the Health Department also falls within this category. The Water Department stands forth alone as capable of being made into an efficient self-supporting organization, selling service at cost to all citizens who are, moreover, now merely consumers and therefore revenue producers, but as citizens of the municipality, also owners of the plant itself.

The Financial Status of the Water Department as Affected by Metering and the Development of the Gunpowder-Patapsco Supplies. — Table XVII shows the annual and cumulative savings by the installation of meters; the saving in capital outlay is the difference between that required for an unmetered distribution system and that required for a metered distribution system. The cost and date of the necessary improvements corresponding to the estimated gross average consumption were taken from the final report of Messrs. Hill and Fuertes, page 72, table X. These amounts do not include the cost of the annual water main extensions—this was considered to be practically the same in both cases.

In the computation of the saving in pumping and filtering, the only items considered are the cost of chemicals, electricity and coal, as they vary almost exactly with the amount of water pumped or filtered. (See Tables VIII and XIX.) The total cumulative savings in filtering and pumping costs alone aggregate $8,623,889 by the year 1960 (Table XVII) while the cumulative saving in capital outlay equals $9,000,257 at the end of the year 1960 (Table XVII).

The saving in annual interest and

Table XX—The Accumulated Reserve Amounts of the Fair Net Return on $1,750,000 and the Future Capital Outlay.

THE ACCUMULATED RESERVE AMOUNTS OF THE FAIR NET RETURN OF $1,750,000 AND THE FUTURE CAPITAL OUTLAY

YEAR **	YEAR *	CAPITAL OUTLAY FOR METERS AND METER BUILDING	CAPITAL OUTLAY GUNPOWDER AND PATAPSCO DEV. METERED BASIS	ANNUAL INTEREST & SINKING FUND PAYMENTS ON OUTSTANDING BONDS	ANNUAL OPERATION DEPRECIATION & MAINS EXTENSION CHARGES	TOTAL ANNUAL EXPENDITURES	TOTAL REVENUE	ANNUAL AMOUNT DUE RESERVE	AMOUNT OF RESERVE ACCUMULATED AT 4% INTEREST COMPOUNDED ANNUALLY
	1922	$270,000		$1,455,596	$2,065,000	$3,790,596	$3,815,000	$ 24,404	$ 24,404.00
	23	295,000		1,455,596	2,065,000	3,815,596	3,815,000	- 596	24,784.16
	24	295,000		1,455,596	2,065,000	3,815,596	3,815,000	- 596	25,179.53
	25	270,000		1,455,596	2,065,000	3,790,596	3,815,000	24,404	50,590.71
	26	270,000		1,455,596	2,065,000	3,790,596	3,815,000	24,404	77,016.34
	27	270,000		1,455,596	2,065,000	3,790,596	3,815,000	24,404	104,503.07
	28	270,000		1,455,596	2,065,000	3,790,596	3,815,000	24,404	133,087.19
	29	270,000		1,455,596	2,065,000	3,790,596	3,815,000	24,404	162,814.68
	30	270,000		1,310,869	2,065,000	3,645,869	3,815,000	169,131	330,458.27
	31	270,000		1,310,869	2,065,000	3,645,869	3,815,000	169,131	521,127.60
	32			1,310,869	2,065,000	3,375,869	3,815,000	439,131	961,103.70
	33		$2,137,923	1,310,869	2,065,000	3,375,869	3,815,000	439,131	1,459,478.85
1945	34		5,471,044	1,310,869	2,065,000	3,375,869	3,815,000	439,131	1,956,555.00
46	35		387,832	1,310,869	2,065,000	3,375,869	3,815,000	439,131	2,474,399.56
47	36		106,672	1,310,869	2,065,000	3,375,869	3,815,000	439,131	789,066.62
48	37		275,308	1,310,869	2,065,000	3,375,869	3,815,000	439,131	1,259,760.28
49	38		499,962	1,310,869	2,065,000	3,375,869	3,815,000	439,131	1,748,201.69
50	39		267,343	1,310,869	2,065,000	3,375,869	3,815,000	439,131	2,258,188.96
51	40			1,310,869	2,065,000	3,375,869	3,815,000	439,131	2,787,850.32
52	41		162,576	1,310,869	2,065,000	3,375,869	3,815,000	439,131	3,338,495.13
53	42		177,736	1,310,869	2,065,000	3,375,869	3,815,000	439,131	3,911,166.14
54	43			1,250,354	2,065,000	3,315,354	3,815,000	499,646	4,467,258.79
55	44			1,250,354	2,065,000	3,315,354	3,815,000	499,646	5,249,595.14
56	45			1,165,140	2,065,000	3,230,140	3,815,000	584,860	6,044,438.95
57	46		89,464	1,113,000	2,065,000	3,178,000	3,815,000	637,000	673,324.95
58	47			1,113,000	2,065,000	3,178,000	3,815,000	637,000	463,518.75
59	48		294,684	1,113,000	2,065,000	3,178,000	3,815,000	637,000	169,175.50
60	49		227,371	1,113,000	2,065,000	3,178,000	3,815,000	637,000	251,061.64
61	50			1,113,000	2,065,000	3,178,000	3,815,000	637,000	670,753.11

* Hill and Fuertes recommended improvements advanced to correspond to the determined consumption in this paper.

** Time of required Hill and Fuertes recommended improvements to correspond to the determined consumption in this paper

depreciation charges on necessary capital outlay for an unmetered system are the amounts which would be received if invested as part of the accumulated reserve.

The depreciation charges were ascertained by allowing one per cent for the yearly depreciation on the Gunpowder-Patapsco Improvements and the Meter Building and four per cent on the yearly depreciation of the meters. The amount of the annual interest charges was determined by taking four per cent of the future capital outlay, as this amount is equivalent to that which would be received if the money were invested as part of the surplus.

Table XX—"The Accumulated Reserve Amounts of the Fair Net Return"—and Fig. 1 show that if the Water Department receives $1,750,000 as a fair net return which covers interest and sinking fund payments on the present outstanding loans also a surplus to finance all future improvements to the water system, no additional loans would be necessary, and the installation of meters over a period of ten years could be executed without a bond flotation.

The determination of the annual interest and depreciation charges for the meters, meter building and capital outlay required for the Gunpowder - Patapsco developments is given in detail on Tables XXI and XXII.

The increase in operating expenses of $37,500 (Table XI) is previously given in "Comparison of Present Cost of Metered and Unmetered System with Estimated Costs for 100 per cent Metered System."

The net saving in operating expenses (column No. 3 of Table XVII) affected by the installation of meters aggragates $8,955,358 in 1960. On Fig. 2 is a graphic representation of the average daily saving in consumption (column No. 3 of Table XVII), the annual saving in cost of pumping and filtering (column No. 4 of Table XVII) and the annual net saving (column No. 12 of Table XVII).

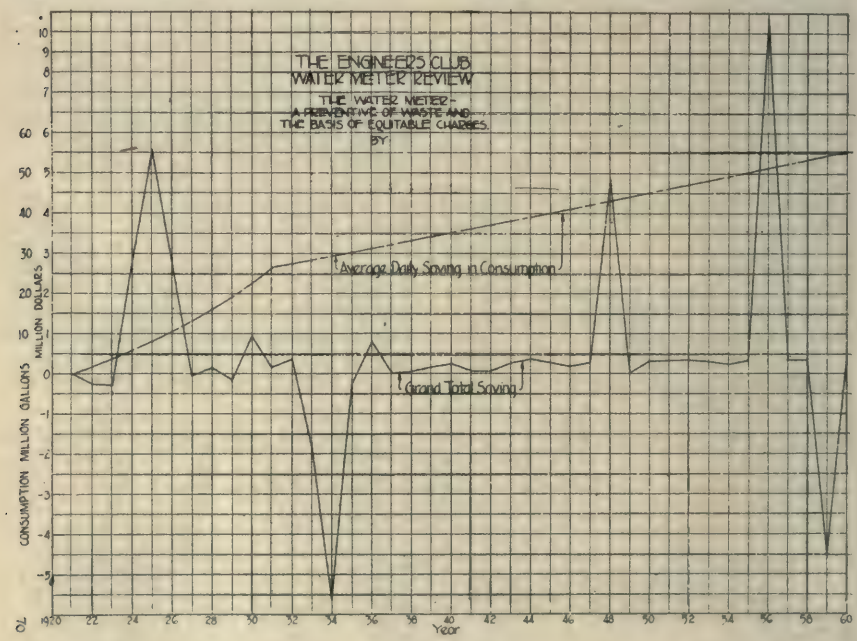


Fig. 2

In all instances when computing the saving of a metered system over that of an unmetered, the quantities shown are actual savings which would be effected, as nothing has been included that could be considered a matter of opinion.

The opinions expressed in this paper are apart from any of the plans proposed by the officials of the present administration and are the results

Table XXI—Saving in Future Capital Outlay and Annual Interest and Depreciation Charges.

SAVING IN FUTURE CAPITAL OUTLAY AND ANNUAL INTEREST AND DEPRECIATION CHARGES FOR GUNPOWDER-PATAPSCO DEVELOPMENTS
(Recommended by Hill & Fuertes - Final Report P.72, Table #10)

YEAR	FUTURE CAPITAL OUTLAY REQUIRED FOR GUNPOWDER-PATAPSCO DEVELOPMENTS			SAVING IN ANNUAL INTEREST & DEPRECIATION CHARGES 5% of 3	INCREASE IN ANNUAL INTEREST & DEPRECIATION CHARGES DUE TO INSTALLATION OF METERS	TOTAL SAVING IN ANNUAL INTEREST & DEPRECIATION CHARGES 4 - 5	CUMULATIVE TOTAL SAVING IN ANNUAL INTEREST & DEPRECIATION CHARGES
	METERED BASIS	UNMETERED BASIS	SAVING DUE TO METERING 2 - 1				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1922					$ 21,600	- $ 21,600	- $ 21,600
1923					22,850	- 22,850	- 44,450
1924		$ 2,989,303	+ $2,989,303	+ $149,465	22,850	+ 126,615	+ 82,165
1925		5,504,788	+ 5,504,788	+ 275,239	21,600	+ 253,639	+ 335,804
1926		472,192	+ 472,192	+ 23,610	21,600	+ 2,010	+ 337,814
1927		135,795	+ 135,795	+ 6,790	21,600	- 14,810	+ 323,004
1928		344,555	+ 344,555	+ 17,228	21,600	- 4,372	+ 318,632
1929					21,600	- 21,600	+ 297,032
1930		1,067,600	+ 1,067,600	+ 53,380	21,600*	+ 31,780	+ 328,812
1931		318,898	+ 318,898	+ 15,945	21,600	- 5,655	+ 323,157
1932		221,696	+ 221,696	+ 11,095		+ 11,095	+ 334,252
1933	$ 2,157,925	217,104	- 1,940,819	- 96,041		- 96,041	+ 238,211
1934	5,471,044		- 5,471,044	- 273,552		- 273,552	- 35,341
1935	387,852		- 387,852	- 19,392		- 19,392	- 54,733
1936	106,672		- 106,672	- 5,334		- 5,334	- 60,067
1937	275,508	89,464	- 185,844	- 9,292		- 9,292	- 69,359
1938	499,962	328,428	- 171,534	- 8,577		- 8,577	- 77,936
1939	287,343	287,371	- 28,972	- 2,999		- 2,999	- 80,935
1941	162,576		- 162,576	- 8,129		- 8,129	- 89,064
1942	177,736		- 177,736	- 8,887		- 8,887	- 97,951
1944		78,648	+ 78,648	+ 3,932		+ 3,932	- 94,019
1945	89,464		- 89,464	- 4,473		- 4,473	- 98,492
1948	394,584	4,616,000	+ 4,221,416	+ 216,066		+ 216,066	+ 117,574
1949	287,371		- 287,371	- 11,369		- 11,369	+ 106,205
1954	78,648		- 78,648	- 3,932		- 3,932	+ 102,273
1956		9,950,780	+ 9,950,780	+ 497,539		+ 497,539	+ 599,812
1969	4,616,000		- 4,616,000	- 230,800		- 230,800	+ 369,012
TOTAL	$14,812,563	$26,542,820	$11,730,257	+ $587,512	$218,500	+ $369,012	

of study while in charge of the Engineering and Construction Division. Varied experience in the design, construction and operation of water works, such as the Loch Raven dam and Montebello filters, together with opportunities to study the local water waste problems have impressed upon me the importance of measuring the efficiency of each unit. Upon assign-

Table XXII—Capital Outlay and Annual Interest and Depreciation Charges Required for Recommended Scheme of Installation of Meters

Year	Capital outlay required for installation of meters. (1)	Annual interest and depreciation charges for meters 8% of 1. (2)	Capital outlay required for erection of meter building. (3)	Annual interest and depreciation charges for meter building 5% of 3. (4)	Total annual interest and depreciation charges for meters and meter building 2+4. (5)	Cumulative total annual interest and depreciation charges for meters and meter building. (6)
1922	$270,000	$21,600	.....	.....	$21,600	$ 21,600
1923	270,000	21,600	$25,000	$1,250	22,850	44,450
1924	270,000	21,600	25,000	1,250	22,850	67,300
1925	270,000	21,600	.....	.....	21,600	88,900
1926	270,000	21,600	.....	.....	21,600	110,500
1927	270,000	21,600	.....	.....	21,600	132,100
1928	270,000	21,600	.....	.....	21,600	153,700
1929	270,000	21,600	.....	.....	21,600	175,300
1930	270,000	21,600	.....	.....	21,600	196,900
1931	270,000	21,600	.....	.....	21,600	218,500
TOTAL	$2,700,000	$216,000	$50,000	$2,500	$18,500	

Note: The 8 per cent in the computation of the annual interest and depreciation charges for the meters includes 4 per cent for interest received if moneys were invested as a part of the cumulative reserve and 4 per cent for depreciation.

The 5 per cent used in the computation of the annual interest and depreciation charges for meter building includes 4 per cent for interest received if moneys were invested as part of the cumulative reserve and 1 per cent for depreciation.

ment to work in the Engineering and Construction Division, I found the greatest need for extensive conservation work on the distribution system, but it is still impossible to determine the efficiency of the system, and this condition will continue until such time as the consumption of the various sections can be determined. The output of the pumping stations and filter plants can be measured, but it is impossible to record any finite consumption with the present unmetered distribution system. I wish to bring to your attention the fact that the greatest expenditure of the department is represented by the enormous mileage of mains required to supply water to all parts of the city and that this network is underground and therefore practically incapable of observation except through consistent conservation methods.

The demand for meters is merely an incohoate expression of protest against the continued wasting of natural resources—in this case a water supply—which is daily becoming more and more a nation-wide problem, and which will eventually create far-reaching difficulties. In this connection consider our depleted oil and coal reserve and the growing decrease in forested areas.

Each day the demand for a "business administration" of various political units is heard, yet the average citizen of Baltimore will countenance the operation of a municipal utility without permitting facilities to measure its production or to determine the amount supplied to each consumer. they do not seem to insist upon, or even encourage, equitable charges whereby justice is extended to all—even though justice to all is the foundation of the constitution of our states and of our country.

I wish herewith to acknowledge the aid given me by my assistants, Mr. W. L. Eisert, Mr. J. S. Strohmeyer, and Mr. M. Goldstein in preparing this paper, and also that rendered by Messrs. Rogers, Kent and Hargett in drafting the sundry tables and plates.

Sacramento, Cal., to Develop Water and Power Scheme.—The Municipal Utility District of Sacramento, Cal., has been created by a popular vote for the development of a municipal water and power development scheme.

The Purchasing Power of the Dollar

An interesting study by the U. S. Bureau of Labor Statistics of the purchasing power of the dollar from 1913 to 1923 is published in the September issue of the Monthly Labor Review. In making this study, which enables one to visualize these changes, the index numbers of wholesale prices of various groups of commodities, compiled each month by the Bureau, have been used as affording a reliable barometer of composite price movements and the average purchasing power of a dollar in 1913 forms the basis of comparison.

The purchasing power of the 1913 dollar varied widely, at different periods, between the different groups of commodities. For all commodities combined, however, it was equal to more than a dollar in most of 1914 and 1915, but after that it declined steadily in value until May, 1920, when it equaled only 40 cts. In the second half of 1921 and the first half of 1922 it had advanced above 70 cts., but since that time it has again declined and stood at 65 cts. in June, 1923. There were even more extreme fluctuations in the dollar's buying power in the case of building materials and of bituminous coal and coke, which are shown separately on account of their importance.

Excavation from the Panama Canal

Excavation from the prism of the Panama Canal by the forces of the United States, to July 1, 1923, aggregated 262,392,915 cu. yd., according to a compilation recently completed by engineers of the dredging division. In addition, states the Panama Canal Record, the forces of the United States have excavated, to that date, 54,534,135 cu. yd. from places outside of the canal prism proper, principally in the terminal harbors. The total of these two figures is 316,927,050 cu. yd. Excavation by the French companies useful to the completion of the present canal has been estimated at 29,908,000 cu. yd. The canal of today accordingly represents an aggregate excavation of 346,835,050 cu. yd. Since 1914 the bulk of the excavation has been classed as maintenance; and of this the greater portion has been due to slides in the Gaillard Cut. The total excavation since 1914 has amounted to 74,759,000 cu. yd.

Method and Cost of Submarine Pipe Line

How 16-in. Cast Iron Water Main Was Laid Under Portland Harbor Between Portland and South Portland, Me., Described in Paper Presented Sept. 19 at Annual Convention of New England Water Works Association

By HARRY U. FULLER
Chief Engineer Portland Water District, Portland, Me.

The contract consisted of moving two submarine electric power cobles, of dredging a trench and laying in it 1,000 ft. of 16-in. submarine pipe, of backfilling with a cover of 3 ft., and of trenching and laying a section of about 70 ft. in length of 16-in. pipe at each approach to the submarine line to connect with the existing pipe lines.

16-in. Class D American Water Works Association specifications cast iron pipe was purchased by the Portland Water District and delivered to the contractor on a wharf near the job.

Flexible joints were inserted in the line every 36 ft., or, in other words, every third joint was flexible. The improved Boston metropolitan type of joint was selected. This is a form of flexible joint in which the lead is held firmly by grooves to the bell of the pipe, the motion being between the spigot and the lead joint.

The depth of water was 35 ft. at low tide in the channels. On the Portland shore it was about 3 ft. deep, and on the South Portland end of the line about 200 ft. of mud flats were exposed at low tide.

Bids were received by the trustees of the Portland Water District, Aug. 28, 1922, the Bennett Contracting Corp., Portland, Me., being the low bidder.

The contract was let to the lowest bidder. He was judged competent to do the work and the outcome justified this action.

Table I shows the unit quantities and costs corresponding to the final estimate.

Equipment.—The contractor provided a derrick lighter 28 ft. by 80 ft. having an 83-ft. boom for dredging, pile pulling, pipe handling, and submarine back filling.

It was decided to lay the pipe by means of a chute suspended between two floating pile-drivers. These two pile-drivers were 20 ft. by 54 ft. and 24 ft. by 54 ft., each having 57-ft. pile-driving gins.

The dredging was done with a clam shell bucket. A dump scow was used to carry the excavated material from the channel portion of the job and deposit it on the flats nearby at high tide.

The pipe-laying chute was 138 ft. long and 3 ft. wide. 126 ft. of this chute was built to a true circular curve of 207 ft. radius. 12 ft. of the upper end was built straight, deflecting downward about a foot at the upper end, below the tangent to the curve to facilitate obtaining straight joints when making the joint. The chute was built up of 5 lines of yellow pine timber belted side by side. The middle line, or keel, was an 8 in. by 14 in. timber, hewed out of the top edge to the true curve. On each side of this keel were lines of 8 in. by 12 in. timbers, bolted flat against the keel with 1-in. screw bolts passing through the 3 lines of timbers, spaced about 18 in. apart and staggered. These timbers were about 23 ft. long and broke joints well. The outside timbers of the chute were formed of

TABLE I—UNIT QUANTITIES AND COSTS

Item	Quantity	Unit Cost	Total Cost
Excavation on land	148 lin. ft.	$14.00	$2,072.00
Laying 16-in. cast iron pipe on land	138 lin. ft.	1.75	242.00
Submarine excavation	1,007 lin. ft.	2.00	2,014.00
Laying 16-in. submarine pipe	1,007 lin. ft.	5.00	5,035.00
Backfilling submarine trench	1,007 lin. ft.	.75	755.00
Moving electric cables	lump sum	.....	200.00
Cutting through dock walls	lump sum	.....	608.00
Lumber left in place	8,000 ft. B.M.	40.00	320.00
Gravel foundation submarine pipe	77 lin. ft.	2.00	154.00
Total cost of work			$11,400.00

6 in. by 12 in. timbers belted flat against the 8 in. by 12 in. timbers and projecting somewhat above the others to form sides to keep the pipe on the chute. These timbers were fastened by ¾-in. machine bolts passing through the 5 lines of timbers, spaced about 3 ft. apart. On the hewed top surface of the keel was spiked a 6 in. by ¼ in. iron plate the entire length of the chute.

The two floating pile drivers were lashed abreast of each other with a 6 ft. space between, the gins being ahead. This was accomplished with timbers fastened across the decks at both bow and stern and diagonal wire cable across the space between. To keep them from listing, an 8 in. by 10 in. timber was lashed between the gins 30 ft. above the deck. In the space between the two drivers was placed the vertically curved chute with its lower end resting in the bottom of the trench and the upper end slung between the two gins of the pile driver. As an additional precaution, the middle of the chute was supported by lines running over sheaves at the stern of the scows, and thence over one of the gin heads and counterweighted with a 2,700 lb. pile driver hammer moving up and down with the tide.

A long wire rope bale was attached to the lower end of the chute to provide a means of lifting it if it became necessary; but this proved to be a hindrance and not needed.

In working on the flats, it became necessary to widen the space between the scows to 10 ft. and remove the timber lashed aloft between the gins that the scows might ground at low tide without undue strain.

The chute weighed about 10 tons, and was built vertically on a wharf, much like laying the keel of a boat.

Laying the Pipe.—The Portland approach to the line having been laid by ordinary land methods with the end of the pipe projecting a few feet beyond the face of the sea wall, and the lighter having dredged a considerable length of submarine trench, the pipe layer was towed into position.

The lower end of the chute was placed in the trench a few feet beyond the end of the approach pipe. Two pieces of pipe were then placed in the upper end of the chute and the lead joints poured and calked. A line was then attached to the lower end of the pipe laying in the chute, and the pipe pulled down the chute by a hoisting engine located on land. Another piece of pipe was then jointed into the upper end of the chute and again pulled down the chute.

This sequence of operations was then continued until the lower end of the pipe in the chute was inserted in the bell of the approach line. A small sheet pile coffer dam around this connection allowed the joint to be made in the ordinary way. From this point the pipe laying consisted simply of adding successive lengths to the line in the chute and pulling the pipe layer along to keep pace with the pipe laying.

In ordinary procedure the pipe was placed on the deck of the layer by the lighter, and then handled from the deck to the chute by a derrick boom attached to the side of one of the gins.

It was found necessary to have ten lines attached to anchors to hold the pipe-layer in position against the force of the wind and tides. Two lines were required to pull the layer ahead, and a snubbing line was required to stop it at the right place. This snubbing line was attached to the pipe in the chute.

During the pipe laying, two spurts or dashes were made. The first spurt was across the channel, it being necessary to lay 192 ft. of pipe between the passage of ships without stopping. Right of way could not be obtained, but the channel had to be crossed when no vessel wished to pass. This was done between noon and 10 o'clock the same evening, and the operation furnished an excellent test of the possible speed of this method of pipe laying.

In preparation the lighter was lashed across the bow of the pipe layer, the three boats forming one unit. The trench having been properly excavated and inspected by the diver, only one other preliminary was attended to. Four sections of three pipes each and two sections of two pipes each were jointed together on the deck of the lighter, making units of 36 and 24 ft. in length. Strong backs or stiffeners, consisting of pieces of timber 6 in. by 8 in. by 12 ft. long with a saddle at the center and each end, were bound to the pipes with wire and prevented any movement at the joints while the units were being lifted into place in the chute. These units were handled by

two whips from the lighter boom, and thus held in position while the lead joint was being run and calked. This method allowed a movement of 24 or 36 ft. for each joint poured in the chute.

The following tables were made from notes kept by the inspector.

Time Required for Various Operation.—Table II shows the actual time required to make joints and pull the rig ahead, and Table III accounts for the entire elapsed time and explains the unforeseen delays.

The second dash was made in order that the scows should either float freely in the channel or if grounded should be on fairly level flats free from large rocks. It was necessary to put in 7 lengths of pipe while the tide was rising and before it had fallen more than a few feet on the following ebb. This was successfully accomplished. After leaving the channel, and as the depth of water became less, the upper end of the chute was carried ahead with reference to the floating pile drivers and lashed in its new position. This was necessary in order that the bottom of the trench should not get too far from the tangent with the bottom of the curved chute. This was done three times and 23 ft. cut off from the upper end each time, leaving the chute 69 ft. long for its journey across the mud flats.

When a point was reached where the end of the pipe was about 40 ft. from the South Portland sea wall, it was held by a tackle and the chute pulled out from under it. A buoy was then fastened to the end of the pipe and it was lowered into the trench while a hole was made through the sea wall and the remainder of the trench excavated. The submerged end of the pipe was then raised and a section of 3 pieces of pipe previously jointed was connected in place. From this point the work was above low tide and done by ordinary land methods.

Test of Pipe Line.—The specifications required that the leakage should not exceed 16.8 gal. per joint per 24 hours for submarine joints, and 8.4 gal. per 24 hours for land joints at a pressure of 150 lb. per square inch.

A cap was made to fit the open bell end of the pipe while testing the line. It was composed of three layers of oak plank laid at right angles to each other and well spiked together, the whole cap being 3 ft. square. Between this cap and the pipe a sheet rubber gasket was placed. Around the pipe and back of the bell was a collar of oak block 5 in. thick held in position by an iron ring 6 in. wide. Holding the cap to the collar were 24 ¾-in. machine bolts.

The line was tested three times during construction with the following results:

FIRST TEST

			Per day
18 submarine joints	at 16.8 gal.	=	302 gal.
10 land joints	at 8.4 gal.	=	84 gal.
	Allowable leakage,		386 gal.

The actual leakage was 5,400 gal. per day, or 14 times the allowable leakage.

SECOND TEST

			Per day
54 submarine joints	at 16.8 gal.	=	907 gal.
10 land joints	at 8.4 gal.	=	84 gal.
	Allowable leakage,		991 gal.

The actual leakage was 4,280 gal. per day, or 4 1/3 times the allowable leakage.

TABLE III—TIME SPENT LAYING PINE ACROSS CHANNEL ON NOV. 8

Time Mexican petroleum boat passed through draw	12:17 P. M.
Time men quit at night	10:00 P. M.
Total elapsed time	9 hrs. 43 min.
Time Actually Laying Pine	
Moving lighter into position	33 min.
Moving rig ahead so that big bell would come in position in chute	26 min.
Placing 6 section in chute	55 min.
Packing, pouring and caulking 6 flexible joints	1 hr. 45 min.
Moving rig ahead 192 ft.	2 hrs. 58 min.
Making lines fast for night	40 min.
Shortest time job could have been done	7 hrs. 17 min.
Time in Delays	
Delay caused by yoke catching over stub in bottom of trench	1 hr. 20 min.
Delay waiting for diver to get into suit	35 min.
Delay putting on strong back	16 min.
Lunch	15 min.
Total delay	2 hrs. 26 min.
Total elapsed time	9 hrs. 43 min.

TABLE II—SHOWING LENGTH OF TIME ON VARIOUS OPERATIONS OF PIPE LAYING ON NOV. 9

	Section No. 1	2	3	4	5	6	Total	Av. Time in Min.
Number of pipe lengths	3	3	2	2	3	3	16	------
Length in feet	36	36	24	24	36	36	192	------
Placing section in chute (min.)	8	10	12	8	10	7	55	9.1
Packing, pouring and caulking joint (min.)	19	14	18	20	18	16	1 hr. 45	17.5
Hauling, rigging ahead (min.)	16	22	30	17	57	36	2 hrs. 58	30
Speed of hauling ahead feet per min.	2.25	1.64	.80	1.41	.63	1	----	1.28
Total	43	46	60	45	85	59	5 hrs. 36	56

THIRD TEST

		Per day
84 submarine joints	at 16.8 gal. =	1,410 gal.
19 land joints	at 8.4 gal. =	160 gal.
	Allowable leakage,	1,570 gal.

The actual leakage was 2,540 gal. per day, or 1 6/10 times the allowable leakage.

The line was evidently growing tighter with time, and no attempt was made to calk the pipe under water.

Several months after the pipe line was completed, a further test was made by closing a valve on the South Portland approach to the submarine line and allowing the water to enter the Portland end of the line through a 2-in. meter. The leakage was found to be negligible.

Cost.—The amount of the Bennett contract was $11,400.

This was in payment for providing everything except the pipe and doing all the work necessary to complete the job.

Very good records were kept as the job progressed, showing the cost of the different items of work. They may be summarized as follows:

Dredging the trench, $2.00 per lin. ft.
Laying the submarine pipe, $5.00 per lin. ft.
Backfilling the submarine trench, 75c per lin. ft.

While this work was progressing, abnormally good weather prevailed, and less than the usual number of unforeseen troubles to be expected on a job of this kind were encountered.

While the contractor did not lose any money on the job, he did not make a profit proportional to his risks, or, in other words, his contract price was too low, and he was fortunate not to lose.

Preliminary work was started the first week in September and the job was entirely completed on Dec. 22, 1922.

The construction of this pipe line was done under the direction of Harry U. Fuller, the engineer of the Portland Water District, with Leonard Metcalf as consulting engineer.

James W. Graham is treasurer of the Water District, and Alfred E. B. Hall acted as inspector.

Conference on Stream Polution

A conference will be held at the Engineers' Club of Philadelphia, 1317 Spruce St., on Oct. 16, 1923, afternoon and evening. The subject under discussion will be the "Polution of Streams," especially with reference to pollution due to industrial waste. Representatives from the national, state and city governments, and several of the industries most interested in the subject will be present. Papers will be read and discussed by a number of engineers who are recognized authorities and are thoroughly conversant with the entire subject.

Operation of Municipal Ice Plant of Omaha

The first publicly owned ice plant in Omaha, Neb., with a daily capacity of 100 tons, was put into operation in 1919, and early in that year a long storage house with a capacity of 9,000 tons was completed.

The demand for municipal ice was so great that it became necessary to increase the manufacturing and storage capacity, and an additional 100-ton unit was completed in 1921, giving a total production capacity in the hottest weather of 200 tons a day, and in cool weather, of 230 tons in 24 hours. Even with this additional capacity in ice making machinery, the demand for "muny" ice could not be satisfied, and another long storage house having a capacity of 20,000 tons was begun in September, 1921, and completed in 1922.

In 1922 57,055 tons of ice were sold, which amount was probably at least one-third, if not a greater proportion, of all the ice sold in the city for household use. The "jitney stations" at which ice was sold at 30 ct. per 100 lb., in 5 ct. and larger blocks, were extremely popular, and the low price enabled many families to enjoy this necessary commodity.

The gross income of the publicly owned ice plant for the year 1922 amounted to $260,755, after deducting from this $13,729 interest accruing on the money borrowed from, and still owed to, the water department, and all expenses of operation amounting to $161,108 there remained a balance of $85,918. Of this amount $28,000 was set aside to provide for depreciation and $8,584 was placed in the sinking fund, thus leaving $49,323 as the net surplus for the year.

The earnings of the ice department have paid for the first ice plant, and it is expected that within four years this entire property which together with equipment and stations, cost approximately $750,000, will have been paid for out of the earnings and will belong to the city of Omaha, without cost and without debt.

Recent Developments in Sanitary Engineering

Review of Recent American Achievement in Sewage Treatment Given in Paper Presented Sept. 10 Before Institution of Sanitary Engineers of Great Britain

By GEORGE W. FULLER
Consulting Engineer, New York City

In addressing a British audience on this general subject, it is appropriate to call attention to the formal arrangement as to sewage disposal provided for in the treaty of 1909 between Great Britain and the United States. This treaty contains provisions whereby along the water courses between Canada and the United States no sewage is to be discharged on one side of the boundary so as to injure life or property on the other. This undertaking deals particularly with the lakes and rivers constituting the great lakes system. In due time both Canada and the United States appointed three members each of a joint commission to deal with this and other boundary questions. Several hearings were conducted to obtain the views of representative citizens and officials in localities especially interested. Testimony of a technical nature was received during 1914, and after further conferences with various parties in interest, a report with tentative recommendations was presented to the respective governments.

Suggested Standard for Control of Boundary Water Sewage.—It was recommended that sewage discharged into those boundary waters should be freed of visible sewage matters and that the bacterial purification should be such that the body of water into which the sewage is discharged shall not cause an unreasonable load to fall upon water filters treating the water in question for use as a public water supply. In substance it was suggested after receiving the views of three Canadian and three American sanitary engineers that the treatment of the sewage should be such that the water receiving the sewage at neighboring water works intakes should not contain more than 500 B. Coli, 100 cc. This suggestion was based partly upon records of performance of the slow sand filters treating highly polluted river waters at Lawrence and Albany and partly upon the 1914 standard for the quality of water used by common carriers as adopted by the H. S. Public Health Service. This standard provides that satisfactory drinking water shall not contain more than 2 B. Coli per 100 cc., and the suggested standard for the control of sewage entering the boundary waters was adjusted to what was considered a reasonable performance as to purification by water filters.

This suggested standard never met with great favor. It was thought to be too stringent, although those who have criticized it have generally viewed it in the light of its applicability for river waters in general rather than for the waters of the great lakes system. Here sedimentation takes place to an extraordinarily high degree, although the sediment on the floor of the lake is greatly disturbed at times by wave action caused by heavy winds. When the muddy river waters found in the southern and western states are judged as to bacterial quality in accordance with this proposed standard, it is found that the latter looks far more reasonable when applied to the analyses of the water after adequate sedimentation.

Another point which has been under dispute in reference to this standard relates to the question of whether chlorination of the filtered water supply shall be viewed as a factor of safety or whether it shall be regarded as a normal part of the water purification system. In other words, shall the proposed standard be applied to the bacterial data obtained from the water purification system before or after chlorination. The international commission was inclined to apply the proposed test to the filtered water without chlorination and to view the latter solely as a factor of safety which might or might not have to do with the public water supply in question.

Still another element of uncertainty attached to this question relates to the fact that the methods of bacterial analyses have changed considerably

during the 20 to 25 years which have elapsed since many of the data were obtained from Lawrence and Albany and set forth in the testimony before the International Commission.

Progress on Boundary Sewage Disposal.—During the war there was very little done in carrying out arrangements to bring about the improvements sought but since the armistice considerable progress has been made in building intercepting sewers, particularly in Buffalo and Detroit. The former city appointed an engineering committee in 1916 to review all data available in respect to the solution of this problem for communities resident on the Niagara River. The result of this was a recommendation that further local data be secured for presentation to the Intrnational Commission before the proposed standard should be officially and finally adopted for application to the Niagara River.

In May, 1922, the U. S. Public Health Service appointed a committee to report upon what modifications if any it would be wise to adopt in the so-called standards for drinking water to be used on railway trains and boats engaged in inter-state traffic. This committee has issued tentative drafts of the reports of some of the subcommittees in order to facilitate discussion, but the final report has not yet been prepared. It is expected that this report and the data secured in the course of its preparation may be of some significance in bringing about a closer agreement as to the extent to which sewage should be purified in order to protect reasonably the public health, through its relation to the purification of public water supplies derived from polluated sources.

In passing it may be noted that the American Waterworks Association and the American Public Health Association are now negotiating for the establishment of joint committees to bring out in due time a new joint edition of "Standard Methods of Water Analyses," of which several editions have been issued by the American Public Health Association during the past 20 years.

Dilution Method.—In America most of the larger cities are situated on or near to oceans or great lakes or relatively large rivers. Consequently the dilution method of discharging sewage into a neighboring body of water has been the prevailing practice. Formerly crude sewage was sent through the outlets near which conditions were frequently unsatisfactory both in the water and on shore. Now conditions are much better in many places. This is due to extending the outfalls so that the outlets are submerged at all times. Frequently multiple outlets have been provided so as to facilitate the mixing of the sewage with the diluting water. Aid has also been received from clarification methods and from chlorination in some instances.

Looking back 20 years it is seen that real progress has been made in cleaning rivers, foreshores and tidal estuaries, as well as in protecting bathing beaches and shell-fish layings. During that interval advance has been made in the art of conserving this natural resource under suitable conditions whereby the oxygenating power of water may be availed of in a reasonable and practical manner.

Much of this progress has resulted from activities associated with litigation. This is notably so in the case of the Chicago drainage canal and the large intercepting sewer in the Passaic Valley in New Jersey, built to discharge its flow into the upper New York Bay. These controversies developed thousands of printed pages of technical testimony before special referees appointed by the U. S. Supreme Court, which took original jurisdiction in these inter-state disputes.

Next spring the Upper New York Bay will begin to receive from the Passaic Valley interceptor the flow of sewage from about 1,000,000 persons; after clarification in sedimentation basins holding about one hour's flow during storm periods. The settled sewage will be dispersed through about 150 outlets on the floor of the bay distributed over an area of about 3½ acres, with each nozzle designed to release a thin ribbon of sewage through an annular opening. These flared openings are ribbed so as to give the liquid a spiral motion with a view to promoting its mixing with the overlying water which has a depth of some 40 ft. at low tide.

The city of Los Angeles, Cal., has now grown to the point where it has overtaxed the capacity of its outfall sewer discharging without any treatment into the Pacific Ocean perhaps 1,000 ft. from shore at the end of a trestle, with no attempt to mix the

sewage flow with the ocean water. The city is now building fine screens and taking steps to secure adequate mixing of the sewage with the ocean water and thus to keep under control the sewage pollution now creating objectionable conditions at neighboring beaches.

In dealing with dilution problems in America much study has been given to English experiences, particularly as to the dissolved oxygen in the lower Thames as related to the discharge of the clarified sewage of London. It is realized that at Boston harbor and some other places the existences of partially unsatisfactory conditions for a limited period over a limited area should be viewed in comparison with the relative cost of treatment of sewage on land and with the relative land area involved as measured by the extent of water surface involved by the arrangements now in use. Naturally this brings out the question of how the public authorities can expend the limited funds available to the best advantage and this proposition in relation to sanitary engineering was never of greater important than at present.

For many years I have been an admirer of the working arrangements whereby the Rivers Boards or Conservancy Boards of England serve their purpose in bringing about cooperative undertakings in line with the requirements of a central authority. In our country it is the state or province which has jurisdiction rather than the Federal Government, and inter-state rivers have received hitherto substantial exemption except where aggravated cases have come under the jurisdiction of the courts. Within the past year the states of New Jersey and Pennsylvania have made progress by the adoption in each instance of identical resolutions by their state departments of health, dividing the boundary stream of the Delaware River into three zones, calling, respectively, in the first instance for clarification of sewage from the cities of either state before discharge into the river; secondly, for sedimentation and chlorination as required; and, thirdly, for oxydation also, where outlet sewers are located in proximity to waterworks intakes. This is a step in the right direction, but it is scarcely adequate for some industrial problems such as acid mine water in streams in the coal fields located on inter-state water sheds.

Disposal of Sewage on Land.—This question depends much on local conditions. In most places in the United States it is entirely unsuitable, notwithstanding it has played such an important part in England for over 40 years and is now used with substantial satisfaction by Paris and Berlin. The sandy tracts owned by the latter city seem to serve well their purpose. Operations are facilitated by the porosity of the soil, the low rates of filtration and surface clogging is relieved by sedimentation of the sewage in cheap earthern basins and by farming operations. Last week I found at the Berlin sewage farms in the vicinity of Wartenberg and Falkenberg that the prevailing crops were cabbages, turnips, grain and hay. In the neighborhood there were said to be 40 artificial ponds through which the effluent passes. These are spoken of as fish ponds, although I saw no signs of fish in any of the half dozen algar-covered ponds which I examined. It is significant that in 1919, when Berlin annexed a dozen or more of its suburbs and became a city of about 4,000,000 people, it abandoned a number of small disposal plants of artificial construction. It is said that the large sprinkler beds of coal at Stansdorf may be abandoned next winter.

In America not much success either hygienically or financially has ever attended the disposal of sewage on land. Broad irrigation or sewage farming has been practised mostly in the southerly portions of the semi-arid regions. In 1921 I found that this question was under most active discussion at Los Angeles, where the rainfall is limited to about 12 in. per year and usually confined to a period of about three months beginning in the late autumn or early winter. Land-owners away from available irrigation water and needing also fertilizing material were most pronounced in their criticism of any arrangement other than land treatment for the disposal of sewage of this very rapidly growing community, which now has a population of about 800,000 people. We found that Los Angeles itself some 25 years ago had irrigated at a small profit about 1,500 acres with sewage. This practice was discontinued following offensive odors which reduced the property values in the neighborhood and announcement

by the health officer of dangers to the public health through vegetables which were grown by renters of irrigated lands. Sixty-four cities in California make use of sewage farming, but most of them experience nuisances and financial loss due to lack of suitable management, area, soil, preliminary treatment and isolation. Other semi-arid states have the same experiences except that no complaints were bothersome at San Antonio, Tex., where the sewage during the wet season is stored with river water in large earthen basins for use during the dry season. The practice met with indifferent success. There is the further objection that flies transmit germs some distance from the locations where pools of sewage are found at intervals particularly after heavy rains. In fact, the unauthorized diversion of sewage during hot weather into neighboring stream beds is a serious menace to the practicability of this method. It doubtless causes the formation in the stream bed of stagnant pools giving off objectionable odors which are credited to the shortcomings of sewage forming at locations some distance from such pools. In northern climates the deep frost penetration (three to five feet) is a serious handicap.

Preliminary Treatment.—American practice varies widely as to the treatment given to sewage before it is disposed of by dilution and also prior to its application to filters or other oxydising arrangements.

Some cities, such as Boston, San Francisco, New Orleans, St. Louis and others on sizable rivers or tidal estuaries, have no settling tanks or screens other than for the protection of pumps.

Fine screens have continued to be the arrangement adopted by New York City for treating its sewage before discharge into the adjacent tidal waters. They are also adopted by Los Angeles. They have not come into general use, in line with the practice of Germany, where I was told last week at Berlin that they are still very well thought of for cities on sizable turbid streams. I found that the German screens, in spite of little or no maintenance during recent years, have performed well. The Wurl screen at Dresden seems to be particularly well thought of by the health authorities at Berlin.

In America fine screening is a part of the activated sludge project at Milwaukee, Indianapolis and Chicago. In spite of such large installations, these devices are not on a stable basis as to general practice. This is partly on account of the hitherto high cost of the Wurl screens, partly because of less removal of sewage solids by screens than by sedimentation. The Dorco and other screens recently put on the market are of less first cost than the "Reinach-Wurl," but their relative desirability will have to be established in part at least from operating data on a sizable scale.

Skimming tanks as at Washington and Toledo are used for removing floating substances from the sewage before its discharge through submerged outlets into turbid rivers.

Sedimentation basins remove more sewage solids than do fine screens, and except in connection with activated sludge plans have come into quite general use in America as a preliminary treatment prior to filtration or discharge directly into certain sizable bodies of water.

At Providence the sludge is removed from the basins at frequent intervals without digestion and barged to sea as will be the case with the Passaic Valley project when it goes into service next spring.

Single story tanks, frequently spoken of as septic tanks, have seldom been built in America during the past dozen years. In most instances the tanks are of the 2-story or Emscher type which have worked well as regards clarification. When receiving the flow of combined sewers the sludge digestion has been quite satisfactory. With the flow from separate sewers the behavior of 2-story tanks has been more erratic both as to air nuisances and irregularity in completeness of sludge digestion.

The cost of 2-story tanks is relatively quite great for some localities, and it is by no means certain that such tanks are preferable in some instances to single story tanks with covers to confine the gases of decomposition and with five or six compartments, each to be operated in rotation. On this basis when one compartment shows gas lifted sludge in its effluent the sewage flow may be diverted from it so that it can remain idle for several months, during which the sludge and scum may digest thoroughly before removal. This method was tried over a dozen years

ago at the old Plainfield plant, but the compartments were too small for fully satisfactory performance. In a measure this is true of the plants at Washington, Penn., Morristown, N. J., and Mount Vernon, N. Y., where the method with some interruptions has been tried with fair success for many years. This method, which was recommended during the summer of 1918 for the disposal works at many army camps of the U. S. War Department, is worthy of more consideration than it has yet received for installations where freedom from air nuisance is highly important.

Sludge Digestion.—In a great majority of cases sludge digestion arrangements have been inadequate for satisfactory results, regardless of whether they involve 1-story or 2-story tanks or separate digestion tanks. In part this is due to a higher water content of the digesting sludge than was earlier assumed to be normally required. This means that the space in the digestion chambers is too small when figured in cubic feet per million gallons of sewage flow or per thousand population connected with the sewers. Furthermore, the sludge drying beds have been too small for continuously reliable performance. This is caused by the long American winters with freezing weather during three to four months, when sludge removal is unmanageable and also by the frequency of heavy rains during the summer. These remarks are not applicable to the climatic conditions prevailing in some of the southwestern states.

Separate tanks for sludge digestion have seldom been tried in the United States except at Baltimore, where the capacities and arrangements are inadequate for securing as satisfactory results as obtained at Birmingham and some plants in the Emscher district.

Oxydising Arrangements. — Time permits me to say only a few words about sprinkler beds, which have generally given very good satisfaction in America, nothwithstanding that some of the plants have been seriously overloaded and others have not been sufficiently isolated to escape completely from complaints as to air nuisance. They have been recommended for adoption in quite a number of instances during the past year or so for cities of 50,000 population or thereabouts, and some of these plants are now being built.

The three largest of recent American projects calling for a high degree of purification of the sewage are those at Milwaukee, Indianapolis and Chicago, providing for about 500,000, 300,000 and 800,000 persons, respectively. Aeration is to be provided for by air compressors, and the aerating tanks are preceded by fine screens. Grit chambers to remove sand provide only for a flow for a distance of say, roughly, 100 ft. and at a velocity of 6 to 12 in. per second.

The activated sludge method is well thought of in America, although actual operating data on a sizable scale are not available other than from the two plants, Houston, Tex., which have been in operation about 5 or 6 years.

Numerous test plants where this method has been investigated in the United States as well as the Houston data have given this method an enviable standing as regards ability to produce reliably a well clarified and stable effluent. But even the extensive investigations at Milwaukee throughout a period of 9 years have shown no easy method of dewatering sludge and drying it for the market. In fact, with present low prices for fertiliser and high transportation charges, the outlook is far from bright for receiving from the sales of dried sludge sums of money approaching the cost of handling the sludge.

In respect to mechanical circulation in aerating tanks, it may not be amiss to say that while no experience with them has yet been obtained in America, I am quite sure that a number of American engineers who have seen them in operation in England think well of them. No doubt the future will see this method given due consideration in America, where projects now building were developed with air diffusion arrangements without any opportunity to give much if any consideration to mechanical circulation. Available data on the cost of the activated sludge process are too meagre to set forth here.

The sludge at Houston is disposed of with substantial success for the present by lagooning, although building operations in the neighborhood of the northerly plant will require soon a change in method of sludge disposal. Chicago is fortunate in having available land on which it may locate

lagoons to which the sludge from activated sludge plant may be discharged by pumping through pipe lines several miles in length.

Operation of MacLachlan Process at Houston.—A summary of operations of the MacLachlan process at Houston, Tex., has recently been obtained by my office as follows:

This plant consists of a conditioning unit made up of a special rotary sulphur burner with pressure blower, which conducts sulphur dioxide fumes into a gassing tank, where the flow of raw sludge is impregnated and put into shape for a quick filtration. The conditioning unit is followed by two continuous sludge filters each having filter drum 40 in. in diameter by 84 in. long. The system has now been in operation for about three months, during which time numerous minor mechanical refinements have been introduced, so that the machines are now operating twenty-four hours daily. Each machine turns out an average of 850 lb. of sludge cake per hour, the cake averaging 79.8 per cent water and ranging from 77 per cent to 81 per cent. The recovery of solids on the filters is averaging 74 per cent and ranging between 70 per cent and 85 per cent. This figure is determined as suspended solids by analysis of feed to and effluent of the filters. The sludge averages 99.5 per cent water. The conditioning unit and two sludge filters are using a total of 9 hp. and the sulphur requirement is averaging 40 lb. per hour to condition the sludge feed to both machines. The labor requirement is one man per shift. As to the type of continuous filter it is my recollection that they resemble those used at paper mills to remove pulp from waste water.

At Milwaukee it is understood that the sludge will be acidified, heated to 160° F., and filtered through a vacuum filter to produce 80 per cent water content. This product will be dried to 10 per cent, moisture screened and crushed. An output of 100 tons is expected daily of dried sludge containing 7 per cent nitrogen, of which 70 per cent is available as fertilizer.

Various types of presses and driers have been tried at activated sludge plants at Houston, Milwaukee, Chicago and Indianapolis, as is also true at numerous meat packing establishments. Unanimity of opinion as to the best arrangement has not been attained.

Chicago let contracts a few weeks ago in the sum of about $5,600,000 for aeration and settling tanks with various conduits and connections for its large north side plant to serve about 800,000 persons, who use about 250 gal. of water each per day. No contracts for the present will be let for dewatering the sludge, which can be lagooned as stated. In the interval required for building, the north side plant, Chicago, can continue to investigate dewatering devices at its Maywood plant on the Des Plaines River.

Indianapolis will defer the installation of its complete dewatering devices. While it is making further tests on a working scale, it will have sand beds on which to discharge the wet sludge.

It is evident that before long much more information will be available than at present on dewatering. But data from one city should not be taken too literally for application elsewhere, on account of variations in the composition of sludge.

Those who have followed the history of the Chicago drainage canal will be interested to know that during the early summer a decree was entered in the United States District Court, limiting the quantity of water to be diverted from Lake Michigan to 4,167 cubic feet per second, as stated in the original permit from Washington. This volume is probably less than one-half of the lake water actually used for many years and a still smaller portion of the canal capacity of 10,000 sec. feet. Such diversion was objected to by various cities in the United States and Canada, where the free board along the shore would be modified, as is also true of depths at shallow portions of the navigable waters, and of the flow at various power plants. Chicago has taken an appeal to a higher federal court, and it is understood that a committee of Congress is soon to conduct hearings on legislation authority sought by Chicago for many years. Consideration has been given for a long time to regulatory works to hold back water in the lakes during wet periods for release at time of low flow. It is understood that these negotiations have been actively taken up with renewed vigor. In the meantime, Chicago is threatened with loss of disposal facilities for about 1,250,000 persons thus upsetting its finan-

cial program which hitherto had been forced to a stiff schedule.

Before leaving this subject of oxydising arrangements it may be well to state that contact beds have not been built in America for large projects for some years. They are too expensive. However, for some residential communities they are of merit, particularly where a high grade effluent is required for small works and where they can be followed by sand beds.

Ground-Water Supplies From Pre-Glacial Valleys

An interesting description of the methods of developing a ground water supply was given by W. D. P. Warren, consulting engineer, Decatur, Ill., in a paper presented last year before the Illinois section of the American Water Works Association. His conclusions follow:

The investigation for a new or of an additional water supply should be conducted along broad lines, keeping constantly in mind that such investigations may be properly extended a distance of 5, 10, 20 or more miles beyond the city limits. A few comparisons in cost may show that a well supply may be developed at distances not heretofore seriously considered. The present lower cost of cast iron pipe and the high cost of reservoir lands, are factors which will influence a final decision.

Keeping clearly in mind the fundamental principles which govern the development of a shallow ground water supply, and realizing the relation thereto of deposits in the preglacial valley, it will be of interest to consider proper methods of development. These may be briefly summarized as follows:

1. An examination of the extent of all possible water shed areas within reasonable distance. As a rough rule, we might say that a city of 2,000 population may economically develop a well supply at a distance of not over 5 miles, while a city of 50,000 might economically develop a well supply at a distance of not over 15 or 20 miles, depending on availability of natural reservoir sites, relative elevations, cost of land, etc. The advantages of a well supply, with low first cost and low operating cost, will justify extending our investigations over a wider field than generally considered necessary.

2. An examination of well records, test holes, borings and other data in the territory under consideration. Such records may often be secured from coal, oil or gas companies, local well drillers, and of most importance in this state, through the State Geological Survey at Urbana. Some such records are confidential, however, the portion relating to depth of glacial drift is not, and may generally be secured to be used in the investigation of a municipal supply.

3. A thorough study of all available records with a view to determining the dip of the rock or shale at base of glacial drift and the location of pre-glacial valley. This study should be made before the location of any additional drill holes is considered. Often the elevations as disclosed by the records of two or three old holes will indicate the direction of the preglacial valley, and a little further investigation should definitely establish its boundaries.

4. The application of knowledge obtained through above studies and the location of test holes in accordance therewith. Such test holes should furnish sufficient additional data to determine the possibilities of any site under consideration.

5. With complete and accurate data upon these principles, a conclusion may then be reached as to the value of such a supply, compared with a surface supply, and recommendations may be made regarding future developments with a full knowledge that all facts relating thereto have been properly considered and analyzed.

Cast Iron Pipe Production in August

The U. S. Department of Commerce announces statistics on the production, orders, sales, and shipments of cast iron pipe for the month of August, 1923. The report includes returns from 12 establishments and is confined to bell and spigot pressure pipe exclusively. The following is a summary by total tonnage for each of the principal items of the industry:

	Tons
Cast iron pipe produced during the month	84,588
Cast iron pipe shipped during the month	84,843
Orders for cast iron pipe specified to be shipped from stock	14,727
Orders for cast iron pipe specified to be made on orders	165,518
Orders for cast iron pipe not specified as to sizes	6,860

Records of Stream Flow

Methods of Obtaining Them Described in Paper Presented May 22 at Annual Convention of American Water Works Association

By C. C. COVERT,
Hydraulic Engineer, W. & L. E. Gurley, Troy, N. Y.

It is not the purpose of this paper to discuss the technical side of stream gaging work, but rather to try to present the subject in a manner that will have a tendency to create greater activities among engineers, plant superintendents, and other who may have an opportunity to assist in the work of obtaining for the further benefit of the nation, data which will enable the engineer of tomorrow to solve in as efficient a manner as possible, the engineering problems which have to do with the use of water, and which will become more and more intricate as the years go by.

The methods used by the engineers of the Water Resources Branch of the United States Geological Survey, have been adopted by the leading governments throughout the world. It is highly desirable that all similar data be collected as nearly as possible by the same methods and with the same degree of accuracy. This feature is an incentive for cooperation with the Survey engineers and has been one of the outstanding inducements for the extensive cooperation now enjoyed in those areas where the greatest degree of activity in the field of stream flow investigations is maintained.

From a standpoint of efficiency, it would be well for all public service corporations, municipalities and others interested in, or having to do with, any problems which involve the use of water, to seek cooperation with the engineers of the Survey, to the end that all such data may be collected in a manner which will permit of the records being published in the official reports or Water Supply papers that are issued by the Federal Government. This cooperation I am firmly convinced cannot be urged too strongly, since it insures the services of an experienced engineer in locating the station and designing and placing the equipment. This feature is essential to good records, for without a proper location and proper field equipment at the station, complications are

Fig. 1—Natural Control of a Stream.

certain to arise which will have a tendency to discredit all, or at least a part, of the records obtained.

Location of Gaging Station.—A thorough reconnoissance is necessary in connection with the establishment of any gaging station. The engineer should be certain that he has selected the best site available. With modern equipment, one is no longer confined to the vicinity of some farm house or highway bridge. The recording gage and the cable way have practically eliminated these conditions as controlling features, and today we can select the location which will produce the best results. Of course, this may mean some additional expense at the start, but when we consider the value of the record and the fact that the station probably will be in operation over a period of years, the cost per year will not be a burden to any project.

The engineer who realizes the importance of a permanent control, well defined channel conditions, suitable place for metering, and also for the location of the gage, and gives all of these features mature consideration, will be able to reduce his operating costs and at the same time turn out final results—discharge in cubic feet per second—in a much more complete form.

The proper location of the gage with reference to the control is also of importance. Any interference here has much the same effect as shifting control.

The gage should not be placed so closely to the confluence of a tributary stream that the readings will be affected by back water at certain stages, or on the up stream side of a bridge where log or ice jams may cause back water conditions.

Type of Gage.—This is important. Some streams will be well taken care of with the ordinary staff or chain gage while others will require recording gages. Often times it is necessary to install a portable water stage register in order to determine this feature. When one has decided to use a water stage register, then to choose the proper type and to plan for its suitable housing, is the next step of importance. Right here let me say that the shelter and the well should be more than toy structures. Many times I have seen what otherwise was a fine installation, spoiled because of a small well or small shelter. There is no question as to the value of having a structure large enough to permit a man to enter, close the door, and work fully protected from the weather. Proper ventilating of both the well and shelter is another feature which should be given careful consideration. The well should be at least 3 ft. square, or better, 4 ft. square. In the Northern countries it should be located well

Fig. 1a—Artificial Control of a Stream.

back in the bank where sufficient earth protection will assist in keeping ice from forming. If of timber, the structure should be of double plank separated by a layer of heavy tar paper. The shelter should be of the same dimensions, in cross-section, as the well. It should be built up of ⅞-in. ship-lap covered with either tar paper or heavy building paper and then shingled. At least one window should be provided and this should be on a level with the gage. The window should be provided with a heavy board blind as a matter of protection. Stock doors may be used, but these should fit tightly and in the winter provision should be made to so close this door that the storms and winds cannot enter.

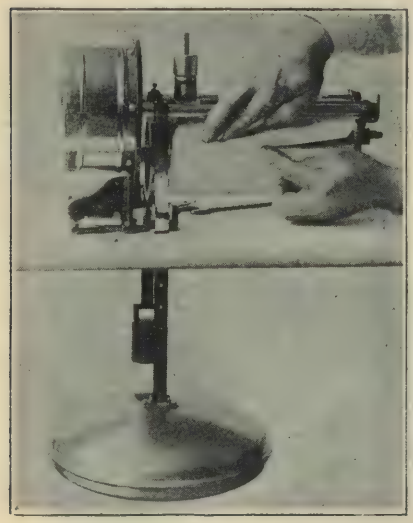


Fig. 2—Graphic Water Stage Record, Showing Method of Placing Record Sheets on Cylinder.

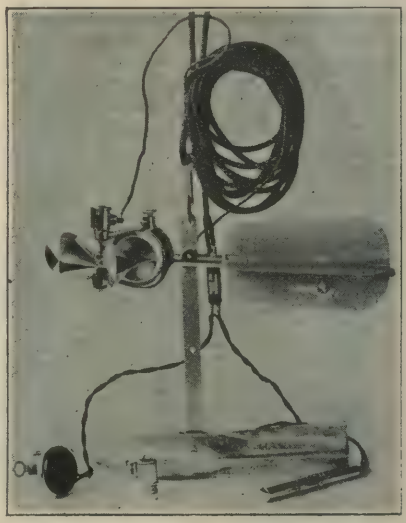


Fig. 4—Small Current Meter with Cable Suspension for Small Streams. This Meter May Be Suspended on Rod and Measurements Made by Wading.

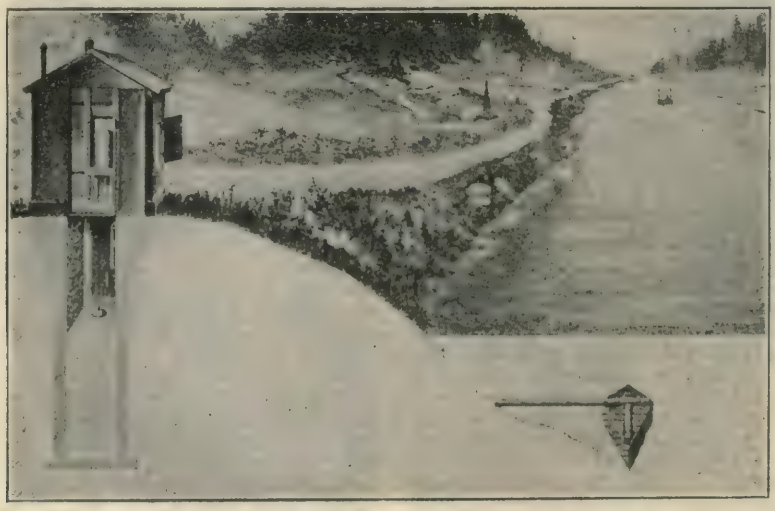


Fig. 3—Typical Current Meter Gaging Station with Automatic Water Stage Register.

The intake pipe to the well is another important consideration. Four inch cast iron pipe or iron soil pipe is suitable for this feature. The outer or river end should be anchored with a concrete pier. This end should also be covered with a screen to prevent as far as possible any foreign matter entering the pipe. After the trench for the intake pipe has been excavated, it is well to provide several wooden sills which may be placed crossways at the bottom of the trench, and underneath the pipe. Vertical supports fastened to these sills will form a support to the mud sill or bed board for the slope or outside gage. Each recording gaging station should be equipped with both an inside and outside gage, for the purpose of more economically and accurately checking the operation of the intake pipe. These gages should be referred by means of an engineers level to some permanent bench mark. Recently I had the experience of checking up the gage height for a sender to a long distance water stage register. No outside or inside gage had been provided. This instrument had been operating with the water surface in the well nearly a foot higher than the water surface in the pond outside. This condition had not been noticed, and of course, no one had a complete history of when the change took place. Therefore, any records which had been made by this instrument were questionable.

Making the Discharge Measurement.—After the gage has been installed and is in operation, the next step of importance is the development of the rating curve. The Price Current Meter as manufactured today meets in a very satisfactory manner most of the problems connected with the regular stream gaging work. Used under favorable conditions, and this the engineer must be on the watch for when choosing the site for the gage, there is no question but that the accuracy of the Price Meter is all that could be desired. Great care is exercised in its manufacture. All parts as now made are interchangeable and the pivot points on which the bucket wheel operates are subject to inspection under the projector where the image of the point is thrown on a screen, the picture being magnified two hundred and fifty times, and the shadow must fit the prescribed form. This inspection insures as near a perfect pivot point as it is possible to obtain. Then with the meter rated at the National Bureau of Standards, one has an instrument which is eminently qualified to meet the requirements of the engineer studying stream flow problems.

Fig. 5—A Practical Type of Weir for Use on Small Streams in Areas Subject to Winter Conditions.

Frequently in the location of a gaging station, highway bridges or

other structures suitable for use in making the discharge measurement will be found available. It often happens, however, that to secure the best location possible it is necessary to build some structure from which the measurements may be made. Standard equipment for this feature is a cable stretched across the river from which a car can be slung for the use of the engineer. Riding back and forth across the stream in this equipment, he is in a position to take observations of the velocity at any desired point. After each discharge measurement, the meter should be thoroughly cleaned and oiled.

For small streams and for low water conditions in the larger streams, it is often possible to make discharge measurements by wading. Measurements are made covering a range from low water to high water. The results of these measurements are then plotted on regular cross-section paper with the gage heights and discharge in cubic feet per second as coordinates, and through these points a smooth curve is plotted. From this curve one can compute the discharge rating table, which when properly constructed, makes the problem of tabulating the daily discharge or, in some cases where the water stage register is used, the hourly discharge, comparatively simple.

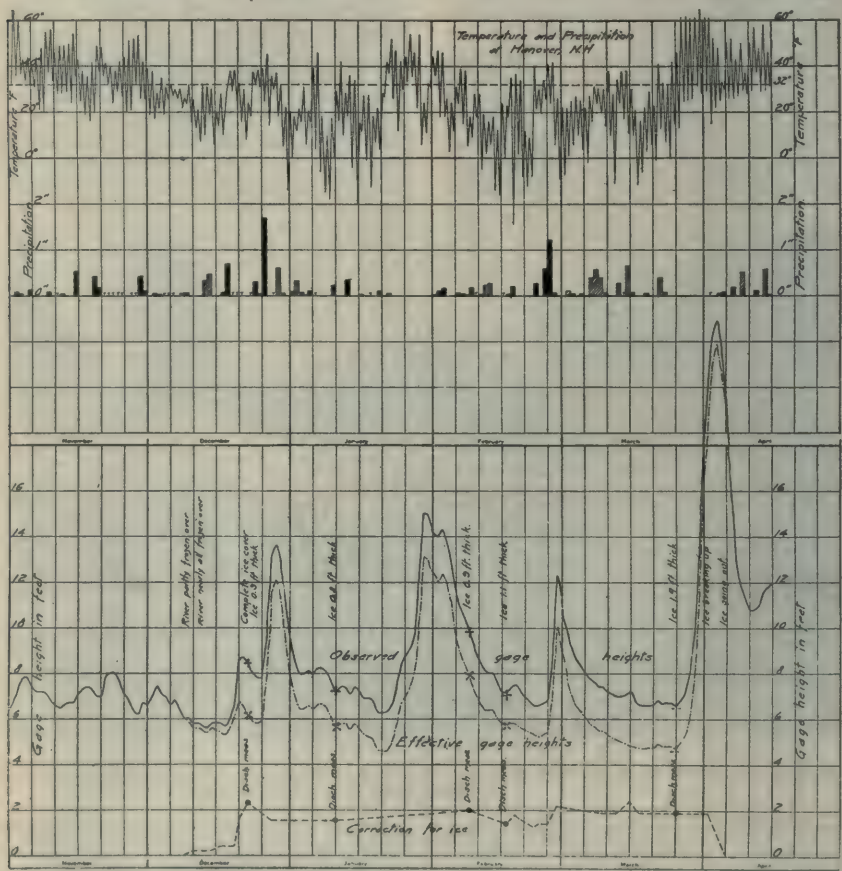


Fig. 6—Method of Working Up Winter Record.

After the daily discharges have been taken out for the period of the record—usually these are worked up at least each year,—a tabulation is made which shows these results in monthly forms, giving not only the daily discharge in cubic feet per second for each day, but the monthly

mean in cubic feet per second, etc., which when published in the Water Supply Papers of the United States Geological Survey, become available for engineers throughout the country. Thus these data are readily available for any problem which the engineer may wish to solve.

Measuring Small Streams.—One of the important problems which it seems to me confronts the average superintendent, or engineer, of a water works plant, is obtaining accurate data on the run-off from small drainage areas. This problem is very difficult to handle in these Northern States where during quite a portion of the year the streams are more or less affected by ice. It has been my experience that the most satisfactory manner in which to handle this problem is to construct some kind of a weir and use this as a control, racing the weir in the same manner as you would rate a regular current meter station. The notch in the weir should be about large enough to carry the winter flow at a depth of 5-in. or 6-in. The observer can then very easily keep the ice broken back for 6 ft. or 8 ft. from the weir and the records will be as accurate as in open water conditions. It will be found practically impossible to make discharge measurements with a current meter on small streams where they are covered with ice. Often the stream freezes to within a very few inches of the stream bed, and no opportunity is offered for using the current meter.

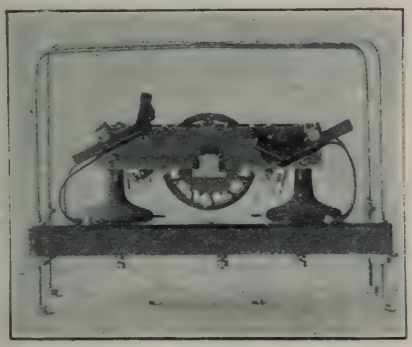


Fig. 7a—Long Distance Sender.

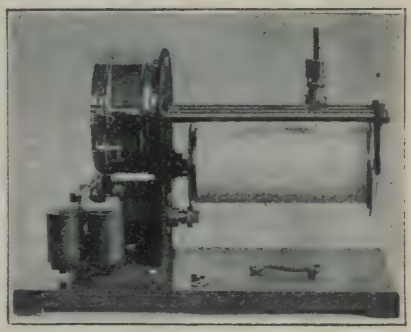


Fig. 7b—Long Distance Recorder.

Obtaining Winter Records.—One of the features that is of importance in stream gaging work in the Northern States is obtaining winter records. At first it was not thought necessary to give much attention to the winter work, but as the engineer began to use actual records of discharge, rather than estimated records based upon rainfall and other climatic data, he also began to realize the importance of having a complete record throughout the year.

Mr. W. G. Hoyt, Hydraulic Engineer with the Water Resources Branch of the United States Geological Survey, developed a graphic method for this work which has been in use since 1913, and which when used by experienced men will give very dependable results.

As soon as ice formation starts on the stream, it is necessary to begin to take discharge measurements to determine the back water effects, since any obstruction to the control is bound to cause back water at the gage. These winter discharge measurements should be made at regular intervals, the interval depending upon the character of the winter. In an area where there is considerable variation in temperature, more discharge measurements are required than in those areas where once the winter starts in, it is comparatively steady through to the break-up period.

A mid-winter break-up, followed by a renewed ice cover with more or less of the old ice cemented together in ice jams and gorges, requires more discharge measurements than would be necessary in case a smooth ice cover remained in place throughout the winter. The U. S. Geological Survey has prepared special forms (Fig. 6) for computations during the frozen season, and on these forms the observed data are plotted in the form

of graphs. These graphs show the following essential data:

1. Observed mean daily gage heights as obtained by twice daily readings or from continuous record of a water stage recorder.
2. Temperature record by plotting consecutively the maximum and minimum temperatures for each day.
3. Precipitation, showing rain by solid black and snow by cross hached lines drawn to scale.
4. Contro. points as obtained from current meter measurements—the vertical cross (+) representing observed gage height of measurement, the inclined cross (×) the effective gage height corresponding to the measured discharge on the basis of the open water rating table, the circle (O) being the difference between the observed and effective gage heights at the time of measurement and is called the "backwater" or "correction for ice."

Having plotted the "observed" mean daily gage heights for each day and the control points mentioned above, together with the temperature and precipitation data and any other information in the form of notes furnished by the observer as to thickness of ice or time of breaking up and going out of ice, the next step is to fill a continuous "correction for ice" graph and a continuous "effective gage height" graph, taking proper account of all the available data. The "correction" diagram and "effective gage heights" should be carried along in conjunction and should act as a check on each other, inasmuch as the diagramatic sum of the two should equal the "observed gage heights." In other words, the "correction" diagram when applied to the observed gage heights should give the effective gage heights to which the open water rating table may be applied, to ascertain the true discharge. The process is simple, but requires practical field experience in its interpretation.

In conclusion, attention is called to the long distance water stage register. This instrument, while comparatively new, is of importance to all who may have reservoirs located at some distance, and who wish to have the record in the office or pumping house. This instrument is especially valuable in connection with a pumping station. The elevation of the water surface in the reservoir may be indicated in the pump house by the indicator, while the superintendent's office may have a continuous record of the changes that have been made by locating the Recording Instrument in his office. The instrument operates on two wires and a ground. The sender operates the contact at .05 ft. of change in the water level, either up or down. This change is transmitted over two wires, one for the falling stage, the other for the rising stage, to the Recording Instrument, where it in turn is marked upon a paper chart in the same manner as is the record from the other types of gages.

Civil Service Examination for Sanitary Engineer

The New York State Civil Service Commission will probably hold examinations on Nov. 3 for the purpose of securing assistant sanitary engineers for the Division of Sanitation of the State Department of Health. The examination is open to nonresidents and covers two positions—one at $3,000 to $3,500 per year and the other at $2,100 to $2,500. The duties of the first mentioned positions require a knowledge of the design, construction, operation and supervision of water supply systems, water purification works, sewerage and sewage disposal systems; the principles of chemistry and bacteriology as applied to sanitary quality of public water supplies, and the principles governing stream polution and its prevention, etc. Candidates must be graduates in a course of civil or sanitary engineering of a technical school of recognized standing and must have had since graduation at least four years of satisfactory experience in sanitary engineering, of which one year must have been in the construction or operation of water or sewage treatment works. C. A. Holmquist, Albany, N. Y., is director of the Division of Sanitation.

Persons in Public Employ.—According to figures of the National Industrial Conference Board, exclusive of pensioners, there are 2,700,000 people on the payroll of national, state and municipal governments. They receive approximately $3,500,000,000 per year. Pensioners and other inactive persons number 670,000, and get $320,000,000 annually.

Some Details of Six Covered Reservoirs

In a paper by George C. Bunker and August G. Nolte presented at the recent convention of the New England Water Works Association the following cases of the covering of reservoirs at the time of their construction were cited:

Arkansas City., Arkansas.—Capacity, 2,000,000 gal.; cost, $52,887.21; shape, circular; dimensions, 156 ft. inside diameter and 14 ft. deep to overflow weir; roof, 5 in. reinforced concrete slab with an 8-in. slope from center to wall; beams, 10 in. by 15 in. spaced 12 ft. on center each way; columns, 10 in. by 10 in; design, ring tension type with walls resting on a subfooting keyed into the rock stratum forming the bottom; the wall is separated from the footing by a specially designed expansion joint, in order to eliminate cantilever stresses.

The location of the reservoir being on public park property, it was decided before completion to utilize the top for tennis and volley-ball courts. The manhole openings and ventilators were so placed that ample space was provided for two tennis courts. Pipe couplings or sockets were installed in the roof slab for the net posts, and also sockets around the wall for posts for fencing the entire area.

Perth Amboy, New Jersey.—Capacity, 40,000,000 gal.; cost, $1,095,556; shape, irregular; dimensions, 900 ft. long by 230 to 370 ft. wide and 25 ft. deep; the roof and floor are of flat-slab reinforced concrete construction, the roof being carried on reinforced concrete columns; the embankment slopes within the reservoir are lined with plain concrete; the roof slab is covered with earth to a depth of 2¼ ft.

Cross Hill Reservoir, London, England.—Capacity, 30,000,000 gal.; cost, £79,000 (1913); shape, hexagonal; dimensions, each hexagonal side has 8 arches, with a span of 30 ft. and a radius of 27 ft. 6½ in., and a span and radius of 17 ft. 4½ in. at the angles; the depth is 32 ft.; roof, 217 concrete domes, each 30 ft. in diameter; columns, 16 hexagonal concrete blocks, 18 in. deep and 3 ft. across between parallel sides, for each column or a total of 432.

The claim is made that this reservoir is of unique design and probably the most economical one ever constructed. The cost was about £2,800 per million gallons of storage as compared with an average cost of £5,000 for several small covered service reservoirs built for the London water supply.

Indianapolis, Indiana. — Capacity, 10,000,000 gal.; cost, $223,500; including pipe connections and appurtenances but excluding engineering; shape, rectangular with rounded corners; dimensions, 254 by 542 ft. in plan by 10 ft. 8½ in. deep; roof, slab 9 in. thick designed for total live and dead load of 470 lb. per square foot; 27 in. of filling was placed on the roof; column heads, 6 ft. 6 in. square extending 5½ in. below bottom of roof slab; columns, 24 in. in diameter, spaced on 18 ft. centers, making a total of 420; floor, groined-arch type of construction; circulation, two brick baffle walls insure uniform circulation of water.

Baldwin Reservoir, Cleveland, Ohio.—This reservoir was only recently completed and is referred to as perhaps the largest covered reservoir in America. Shape, rectangular; dimensions, 1,035 by 551 ft. in plan by 39 ft. deep; a division wall divides it into two basins of equal size; the floor is of flat-slab plain concrete; the roof is of the groined-arch panel type supported by columns 30 in. in diameter which are strengthened by stiffening walls forming a cross in each basin; special attention was given to the design of the inlets and outlets to ensure a good circulation of water.

Montreal, Quebec, Canada.—Capacity, 50,000,000 gal.; shape, rectangular; dimensions, 512 ft. by 525 ft. in plan by 15 ft. 6 in. deep; the roof and floor are of flat-slab reinforced concrete construction, the former 6 in. thick and the latter 8 in. thick; there are 1,330 reinforced concrete columns, 16 in. in diameter, spaced 12 ft. 6 in. apart, center to center, both ways; the footings are 5 ft. 8 in. square, of the tapered type, and extend upward above the basin floor a distance of 16 in.

Sub-Surface System for Collecting Water

How Newton, Mass., Obtains Its Supply From Ground Water Described in Paper Presented Sept. 19 at Annual Meeting of New England Water Works Association

By EDWIN H. ROGERS
City Engineer, Newton, Mass.

The municipally owned and operated water works of Newton, Mass., draws its supply entirely from underground sources located in the Charles River valley.

The collecting structures are located in a reservation in the adjacent town of Needham. The total area of the reservation is about 750 acres, but the portion proven and demonstrated to be water bearing gravel capable of practical development for yielding water does not exceed 150 acres, and it is within the limits of this area that the collecting system is located and draws its sub-surface supply.

The Collecting System.—This collecting system, as designed and constructed under the supervision of the city's engineering department, consists of a wooden collecting conduit built in 1889, a double line of open joint 24 in. vitrified pipe laid in 1894, and a large concrete well constructed in 1911.

The wooden conduit is 4 ft. square in section, 3,769 ft. in length, laid level, with its invert grade line about 10 ft. below the average level of the river, which is in general from 50 to 75 ft. distant. This conduit is constructed of hemlock, green at the time it was used, and the planks composing its top, bottom and sides are laid with open longitudinal joints, permitting the water to infiltrate into the conduit from the adjacent water bearing gravel. On either side of the conduit, 2½ in. driven wells are located, reaching to average depths of from 15 ft. to 80 ft. below the conduit and aid the flow of the ground water into the conduit. Its top is generally 8 ft. below the ground surface.

From one end of this conduit, a cast iron pipe line is laid under the river to the pumping station, which draws the water from the collecting system by gravity and pumps it directly into the distribution system. A 10,000,000 gal. reservoir located on top of one of the hills of the city controls the pressure, acting as a compensating reservoir and a reserve supply as well.

From the other end of the wooden conduit, a double line of open joint 24 in. vitrified pipe is laid, and extends for 3,188 ft. through nearly level land but little above the river level towards rising and hilly ground in a direction generally away from the river. The invert grade of these pipe lines is 2 ft. above the invert of the conduit at its start and rises on a slight grade, totaling 1.1 ft. in its whole length. They are laid 10 to 12 ft. below the surface of the ground. These pipe lines also have tributary 2½ in. driven wells, similar to the wooden conduit.

From the same end of the wooden conduit from which the pipe lines branch is laid a tight conduit line about 3,570 ft. in length to the circular concrete well, 28 ft. in diameter, located about 500 ft. from the bank of the river, with its bottom about 32 ft. below the average river level. This well contains two 6 in. vertical, submerged, motor driven centrifugal pumps, which operate continuously a large part of the year and discharge about 1,000,000 gal, of water per day into the wooden conduit through the pipe line by which it is connected.

The percentage of the supply contributed severally by the wooden conduit and the pipe lines is not known and difficult of determination; experi-

Table I—Analyses of Water of Newton, Mass.
PARTS PER 100,000

Year	Turbidity and Sediment	Color	Residue on Evaporation	Ammonia Free	Ammonia Albuminoid	Chlorine	Nitrogen as Nitrates	Nitrogen as Nitrates	Hardness	Iron
1893-1897	None	.03	5.68	.0004	.0023	.41	.0238	.0000	2.6	.012
1898-1902	None	.02	6.04	.0004	.0030	.45	.0357	.0000	2.5	.004
1903-1907	None	.05	6.30	.0008	.0040	.45	.0362	.0000	2.7	.011
1908-1812	None	.01	6.36	.0005	.0028	.48	.0251	.0000	2.7	.006
1913-1917	None	.02	6.79	.0008	.0037	.54	.0395	.0000	2.7	.006
1918-1922	None	.01	6.00	.0006	.0031	.43	.0299	.0000	2.4	.008
cut Average	None	.02	6.20	.0006	.0032	.46	.0317	.0000	2.6	.008

ments are now under way to obtain this information approximately.

There are numerous manholes along both the wooden conduit and the 24 in. pipe lines, which afford an easy opportunity to observe the immediate ground water elevations. The elevations vary according to the seasons of the year and conditions of rainfall, sometimes being only slightly below the river level and at other times from 4 to 5 ft. below.

A severe test of the adequacy of a ground water supply is increased use during summer months occasioned by shortage of rainfall at a time when the ground water table is low. The maximum draft on this supply in succeeding years for short periods of equal length has been increasing in a slight diminishing ratio, in the period in question, while the total yearly consumption has been growing in a somewhat increasing ratio.

The total monthly quantity which the city may take from this reservation is limited by statute. This amount is variable within certain limts, as determined and approved by the State Department of Health, and is regulated according to the rainfall.

Analytical Data of the Water.—Analyses of the water as averaged for each five year period for the past 30 years are shown in Table I.

An examination of the average yearly analyses, plotted graphically, shows no curve indicating a deterioration in quality, but on the contrary that the average quality has been practically constant throughout this period for which data is available.

This description of this city's collecting system and analytical data as to the water produced is offered as an instance of a ground water drawn from a favorable locality, which shows but little variation in quality through a considerable period, and it may also be noted as a supply that has not deteriorated by reason of increasing hardness or iron content under constantly increasing demands. The maintenance of its quality is unquestionably due to the fact that it has not yet been drawn upon beyond its safe capacity at any time, but past and present conditions indicate that the restrictions imposed by the State Department of Health as to the quantity to be drawn are safe to follow, and conservatism as to any increased use of this supply is to be favored.

Experiences With the Geophone in Locating Underground Leaks

Some interesting information on the use of the geophone by the Roanoke Water Co., Roanoke, Va., is given in the September Journal of the American Water Works Association by Francis W. Collins, consulting engineer for the company. We quote from Mr. Collins' article as follows:

The instrument exteriorly consists of two discs, each about 1 in. thick and 4 in. across, from each of which leads a tube ending in an earpiece. The whole affair is not unlike a stethescope.

In use the discs are placed on the road surface and an earpiece in each ear. If a leak is suspected in a given locality, by placing the two discs as far apart as the lengths of tubes permit, it will be found that the noise in one ear will be louder than in the other. The less loud disc will then be shifted backward and forward until the sounds from both are equal. The assumption follows that the sound is in the plane perpendicular to the straight line joining the two discs. Mark this observation spot, then proceed along the direction of this plane forward or backward whichever way, on trial, intensifies the noise.

The time necessary to locate an ordinary leak when within 50 or 75 ft. of it is usually only a few minutes and not over 15 or 20.

Suggestion on Use of Instrument.—There are some points of interest worth following by one using the geophone for the first time:

(a) The operation must be carried on at a time of no traffic or other street noises. It was found that a street sweeping machine of the revolving broom type two or three blocks away on a brick pavement made so much noise that it was distinctly heard in the geophone. The early morning is practically the only time, except in outlying districts, the instrument can be used.

(b) The operator must learn what to listen for. He may pick up all kinds of noises.

(c) The noise from a leak, apparent

through the geophone, will depend on against what the leaky water impinges. If the stream is against a ledge of rock, a roar like a cataract may result; the volume of sound does not necessarily indicate the size of the leak. No observations have been made as to the effect produced by different characters of apertures through which the leak might be taking place.

Examples of What Geophone Will Do.—Although not tested under all conditions so as to determine what the geophone will not do, enough has been learned through its use to prove its value for what it will do. We are now interested in learning the smallest leaks it will disclose and under what conditions.

Three examples will show what it will do:

(1) A ½-in. service 2½ ft. deep, leaking a stream smaller than a lead pencil, under 8 in. of brick and concrete base pavement was heard 50 ft. away (how much farther it might have been heard was not determined) and was located exactly, saving nearly the cost of the geophone through not having to cut up the pavement. There was no surface indication of where the trouble was. It was only known that there was a leak in a certain block.

(2) A leaking ½-in. service in a 6-in. reinforced concrete pavement, 3½ ft. deep, was located. Before starting, the suppositions were that a joint in a 16-in. main might be blown, or a valve was leaking, or a service had gone out. The geophone got on the job and left no doubt that a service was involved and located the exact spot at which to break through the pavement with a consequent saving in cost. It was only necessary to open the concrete pavement enough to permit a man to work.

(3) The local gas company was laying a main parallel to ours and discovered a considerable volume of water which was reported leaking from the water main. Inspection at fire hydrants, meter and valve boxes failed to disclose any leaks. The geophone was used showing no leaks whatever. Later it was proved that the water was ground water from a clayey soil.

Method of Locating Hydraulic Gradient in a Water Tunnel

Extract From the 1922 Report of the Department of Public Works of Chicago

The 12 ft. Western Ave. water tunnel now under construction at Chicago will supply the proposed pumping station at its north terminus and will be fed from the Southwest water tunnel at 73rd and State Sts. The Southwest lake and land tunnel comprises 12,990 ft. of 14 ft. section between the Edward F. Dunne crib and the shore shaft at Yates Ave., 15,897 ft. of 12 ft. section between the Yates Ave. and State St. shafts, and 23,072

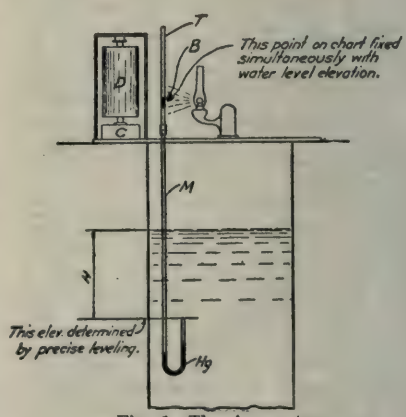


Fig. 1—The Apparatus

ft. of 9 ft. section from the State St. shaft to the Roseland pumping station. The form of all sections is horseshoe.

At present the Southwest water tunnel supplies pumps 1, 2 and 3 of the 68th St. pumping station and the Roseland pumping station. The maximum demand of the two stations is 220 M. G. D. The 68th St. pumping station is supplied through a 6 ft. gate at 73rd St. and Oglesby Ave., this connection being enlarged to an 8 ft. circular section immediately north of the gate shaft, and is continued north to the section shafts of pumps 1, 2 and 3.

For the purpose of ascertaining the

maximum amount of water that can be taken from the tunnel at 73rd and State streets without causing the levels of the suction shafts at 68th St. station, and especially the wet well of Roseland station, to be lowered beyond a safe operating depth, the following method of locating the hydraulic gradient was used:

Since all available methods or instruments were considered unsuitable an intsrument (Fig. 1) was devised that eliminates all lost motion, and will accurately record extremely small differences of elevation. The instrument consists of a manometer M. made of ¼ in. iron pipe, a glass tube "T" of convenient length, and a Pitometer Co.'s photo recorder, which consists of a lamp "L," a drum "D" driven by a clock "C." These recorders are in daily use in connection with water surveys of the division, and were therefore available.

The manometers were made approximately 12 ft. long from the bottom of the "U" to the point of connection with the glass tube.

In use the "U" bend of the manometer is filled with mercury to about half the height of the short leg; the remainder of both short and long legs are then filled with water. The glass tube is then attached, filled with water to a convenient height, depending upon the location of the recorder, and a kerosene bubble "B" dyed with aniline dye, about 2 in. in length, is placed on top of the water level in the glass tube.

Due to the irregularities of both glass tube and manometer the instrument is now calibrated by placing a long glass tube on the short leg of the manometer and varying the head of water in this glass tube. In this manner an accurate calibration of the movement of the bubble is made.

The instrument is placed in the shaft at such a depth that the short leg of the manometer is always submerged, the glass tube placed in the recorder, a sheet of sensitized paper placed on the drum, and the lamp lighted. From the sketch it can be seen that all variations in the submergence "H" will be transmitted to the bubble "B" and an accurate and continuous record of every piezometric height will be recorded.

Four of these instruments were used in making the survey. No. 1 was placed in the wet well of the Edward F. Dunne crib, No. 2 in the Yates Ave. shaft; thus Nos. 1 and 2 gave the hydraulic gradient of the 14 ft. lake tunnel. No. 3 was located in the State St. shaft, which record compared with No. 2 gave the hydraulic gradient of the 12 ft. section, and finally No. 4 placed in the wet well of the Roseland pumping station determined the changes in elevation and when compared with No. 3 gave the hydraulic gradient of the 9 ft. section.

Precise levels were run from standard benches to the shafts, and accurate elevations of the manometers were determined.

Attempts were made to pass correct elevations from the shore to the crib by reciprocal leveling, but due to atmospheric conditions elevations were not considered sufficiently accurate for use. The established elevation of the crib gauge was used in locating the manometer elevation of No. 1 instrument.

These four instruments were operated simultaneously, giving the piezometric heights at the points above stated for every instant throughout the 24 hours.

During the run tests were made each day to check the accuracy of the indicating bubble by measurement of submergence at each instrument.

The value of Q or flow during each day's run was taken from the station instruments and is probably not more than 2 per cent in error.

From the known quantity of flow and hydraulic gradients determined by the instruments, values of "N" in the Kutters formula for determining the value of "C" in Chezy formula $v = c v r s$ were found.

These values were surprisingly high and some doubt as to their accuracy arose, but subsequent checks proved that the values originally determined were correct.

The value of "N" as applied to the 14 ft. or lake section cannot be taken as final due to the absence of positive information as to the true elevation of instrument No. 1. It is hoped that in the coming year elevations can be successfully passed to the crib and the elevation of instrument No. 1 determined.

Without going into a detailed tabulation of the results, the average values of N were:

14 ft. section Dunne Crib—Yates Ave...n=.019
12 ft. section Yates Ave.—State St.....n=.017
9 ft. section State St.—Roseland Pump. Station .....n=.016

Water Works and Sewer Contracts Awarded During the Last 44 Months

The accompanying tables show: First, that the waterworks and sewer contracts awarded during the last half of each year exceed in volume those awarded during the first half; second, that there is not a month in the year without a very large volume of waterworks and sewer contracts; third, that each year shows a gain over its predecessor in the volume of contracts awarded in this "hydraulic field."

The volume of irrigation and drainage contracts will surprise any one who has not followed closely statistics of this sort.

WATERWORKS CONTRACTS EXCEEDING $25,000 IN SIZE.

	1920	1921	1922	1923
January	$ 1,144,000	$ 519,000	$ 1,727,000	$ 4,720,000
February	2,172,000	2,927,000	652,000	2,730,000
March	2,213,000	2,028,000	1,093,000	15,149,000
April	2,719,000	3,342,000	2,673,000	8,544,000
May	1,382,000	4,944,000	3,568,000	7,329,000
June	1,461,000	3,485,000	5,124,000	4,045,000
July	3,793,000	3,106,000	811,000	3,803,000
August	775,000	2,404,000	4,494,000	3,678,000
September	743,000	1,487,000	3,906,000	.....
October	11,169,000	900,000	7,686,000	.....
November	2,151,000	4,698,000	2,161,000	.....
December	1,051,000	10,752,000	1,835,000	.....
Total	$30,773,000	$40,602,000	$35,730,000	.....

Note.—About 100 per cent must be added to the annual totals to give the grand total of contracts awarded in the United States.

A great deal of waterworks construction is done by directly hired labor and is not included above.

Waterworks buildings are not included above.

SEWER CONTRACTS EXCEEDING $25,000 IN SIZE.

	1920	1921	1922	1923
January	$ 1,864,000	$ 3,147,000	$ 2,267,000	$ 3,322,000
February	623,000	2,445,000	2,462,000	2,131,000
March	1,283,000	2,862,000	3,796,000	4,477,000
April	4,124,000	3,817,000	2,794,000	5,497,000
May	2,315,000	2,162,000	5,722,000	9,052,000
June	2,349,000	3,802,000	5,158,000	6,501,000
July	3,163,000	3,986,000	1,869,000	3,183,000
August	2,437,000	3,988,000	3,450,000	13,753,000
September	2,319,000	5,064,000	3,340,000	.....
October	8,052,000	2,829,000	4,996,000	.....
November	4,572,000	2,783,000	5,349,000	.....
December	2,967,000	2,549,000	2,381,000	.....
Total	$36,068,000	$39,384,000	$43,584,000	.....

Note.—About 100 per cent must be added to the annual totals to give the grand total of contracts awarded in the United States.

A considerable amount of sewer construction is done by directly hired labor, which is not included in the above totals.

IRRIGATION, DRAINAGE AND EXCAVATION CONTRACTS EXCEEDING $25,000.

	1920	1921	1922	1923
January	$ 1,542,000	$ 1,266,000	$ 2,091,000	$ 548,000
February	787,000	306,000	419,000	365,000
March	3,151,000	1,626,000	608,000	28,993,000
April	416,000	580,000	1,736,000	2,506,000
May	404,000	2,632,000	776,000	3,553,000
June	605,000	1,240,000	2,628,000	1,174,000
July	1,942,000	609,000	1,498,000	6,902,000
August	4,179,000	89,000	6,920,000	2,337,000
September	859,000	9,025,000	876,000	.....
October	1,086,000	373,000	2,390,000	.....
November	772,000	726,000	1,741,000	.....
December	477,000	707,000	864,000	.....
Total	$16,220,000	$19,179,000	$22,547,000	.....

Note.—About 100 per cent must be added to the annual totals to give the grand total of contracts awarded in the United States.

Sewer Trenching at Evanston, Ill., With Dragline

The city of Evanston, Chicago's largest north shore suburb, has undertaken the construction of a $150,000 sewer. This sewer is called the northwest trunk sewer and runs from the Evanston-Wilmette line, the northern boundary, south and into the drainage canal. Its purpose is drainage and sanitation of the northern part of the city.

The job was started in the late spring and one Northwest gasoline operated dragline with a 40 ft. boom and a 1 yd. bucket has been used to dig the entire cut.

The cut is 20 ft. deep and the going was tough. The first 5 ft. was dug through brown clay and the last 15 ft. through exceedingly sticky blue clay. The machine made a single cut and the waste was piled on either side. When the ditch was completed it was 28 ft. wide at the top and graded by the machine to a 7 ft. width at the bottom.

The cut was made in two sections. The first ran south from the city line. The second section was run from the canal west till it met the southbound pipe and here the two were joined.

Ferguson vitrified segment block is being used for the pipe. This is being laid in four different diameters. For the first 3,000 ft. the pipe is 5 ft. in diameter, for the next 1,400 ft. it is 48 in. in diameter, for the next 2,000 ft. it is 42 in. in diameter, and in the last 1,500 ft. it is 36 in. in diameter.

The pipe laying gang went in as soon as the dragline reached the desired depth and followed along right behind the machine. The dragline dug 100 lin. ft. in a day of 10 hours, removing 1,000 cu. yd. of dirt.

The pipe laying gang was followed by a gas shovel with a ¾ yd. bucket which leveled the waste piles and back-filled the trench, filling at the rate of 150 lin. ft. of trench in 10 hours.

The work is being done by Cannell & Conrad Construction Co., Louisville, Ky.

Trench Excavation With Dragline for Northwest Trunk Sewer of Evanston, Ill.

Pumpage and Operating Cost of Cleburne, Tex., Water Works

The September issues of the Water Works Journals throughout the country mentioned the hardships many water systems have had the past summer in keeping a supply of water and pressure in the mains. In many cases noted, it has been impossible to supply the demand and the customers have been appealed to not to sprinkle, wash cars, and in every way reduce the consumption. In Cleburne, Tex., however, while there has been more water actually used this past summer, the service has been better, the pressure greater, and during the evening sprinkling period the pressure was increased and maintained for several hours or during the maximum demand.

In previous years the very best pressure maintained during the sprinkling period was 25 lb. per square inch, while during the past summer the lowest pressure was 55 lb. and during the sprinkling period this was increased to 75 lb., making it convenient for one to sit on the front steps and sprinkle the entire lawn.

While there has been no additions to the water supply in the way of additional wells or other sources, neither has the rate been changed, yet the dry season of the past summer was not felt by the water department. This is the first summer that such conditions have prevailed, although the water system has been established for more than 35 years.

The following comparative cost sheet of the Cleburne, water department, of which J. W. Hockaday is superintendent, is interesting:

	Aug., 1922	Aug., 1923
Total gal. pumped	21,577,000	16,166,000
Total gal. metered	13,226,486	15,544,000
Total per cent metered	.613	.961
Total meter collections	4,755.00	5,313.25
Total meter collection per 1,000 gal.	.359	.342
Total cost to pump per 1,000 gal.	.347	.259
Total operating cost	$4,585.00	$4,191.00

	Aug., 1922 Cost Per 1,000 Gal.	Aug., 1923 Cost Per 1,000 Gal.
Power	.185	.1285
Operating force	.045	.0397
Station repair	.011	.0027
Sewer maintenance	.01	.0079
Station repair	.....	.0006
Auto Expense	.013	.....
General Repairs	.012	.....
Office expense	.0053	.....
Station expense	.0012	.....
Truck acct.	.....	.0009
Oil acct.	.005	.001
Packing acct.	.0034	.....
Office salary	.034	.0284
Tap acct.	.....	.0093
Pipe line repair	.....	.0059
Meter repair	.0144	.0224
Meter read	.0034	.0029
Gasoline acct.	.0023	.0029
Insurance acct.	.....	.0038
Electric repair	.....	.0021
Shaft acct.	.002	.....
	.347	.259

Determining Comparative Efficiencies of Pumping Stations at Chicago

During the past year a method of comparing efficiencies of the ten major pumping stations of Chicago was devised by the Efficiency Division of the Department of Public Works and is now in use. The method used is arrived at by making a heat balance of each station, using the official acceptance trials of the apparatus as a base of 100 per cent. It is assumed that where the apparatus is properly maintained and operated, results closely approaching, if not meeting, the official results should be obtained. Thus, knowing the work done, together with the fuel consumed, a close estimate of the operation efficiency can be made by comparing the coal consumed in operation with the amount of coal that should be used according to the official acceptance tests. The information used in computing and tabulating the comparative efficiencies is taken from the daily log sheets and recording instrument charts of the various stations.

New Trade Publications

The following trade publications of interest to water works men, engineers and contractors have been issued recently:

Sewage Ejectors.—Yeomans Brothers Co., 1423 Dayton St., Chicago, Ill., have issued a new bulletin describing the Shone system of pneumatic sewage ejectors. The bulletin is of particular interest because it contains the first complete information given out on the new type S. D. V. Shone ejector, in which the piston valves are detached from the ejector and located outside of the ejector pit.

Water Chlorination.—Two interesting publications on the subject have been brought out recently by Wallace & Tiernan Co., Newark, N. J. One of these deals with the chlorination of small water supplies, the other with the chlorination of medium sized water supplies. Details of the apparatus and its application are given.

Sewage Screen.—The Link Belt Co., 300 W. Pershing Road, Chicago, has issued an interesting bulletin on the Tark sewage screen. A description of the screen and the way it operates is given, together with numerous illustrations of the various parts, as well as of a complete unit. Included in the booklet are descriptions of installations at Pleasantville, N. J., and at the activated sludge plant at Milwaukee.

Railways

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.

221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*

LEWIS S. LOUER, *Vice-President and General Manager*

New York Office: 904 Longacre Bldg., 42d St. and Broadway

RICHARD E. BROWN, *Eastern Manager*

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Vol. LX. CHICAGO, ILL., OCTOBER 17, 1923 No. 4

Obsolescence

Acutely in every railroad or public utility rate case, and perennially among the duties of every administrator of large operating properties, there arises the problem of obsolescence.

It need scarcely be noted that a problem of such recurrence can not be simple, and it is probably better even to refer to the "problems" than to the "problem," for there are two distinct major questions involving obsolescence. The first of these is—How much shall be set aside annually in a fund or reserve to provide for the probable displacement of present equipment by equipment of improved type or design? The second question relates to the present value of equipment in use. In a rate case it is the direct and simple, though not easily answered, query—What is the value? While in the routine of administration there is the frequent question—Is it, in view of advances and improvements in the arts, any longer economic to operate this or that machine?

The questions are related but not completely answerable from the same data. In determining the annual requirement one must consider expectations and even possibilities. If, for example, a telephone system is involved, it is obvious from the past history of the business that there is no reasonable expectation that large portions of the equipment will ever be worn out in service. Rather shall we anticipate that improved forms will take their place, and the old units will be sold as junk. But obviously we cannot predict with certainty the time at which such displacements will occur; and we therefore make the best "guess" possible based upon the past history of the art. The actual time may be either longer or shorter than we anticipate, and in view of the latter possibility it is the part of conservatism to base the annual provision upon a moderate assumption as to length of life. If the property outlives the time covered by the provision the annuity can be discontinued and

its accumulation so handled as to ensure fairness to all concerned, but if it is not provided, irreparable losses and even financial disaster may occur.

In estimating the present value of a property the prospect of future changes cannot be considered. If, for example, during the past three years there has been no important change in the design of steam locomotives for a given class of service, a locomotive of this class purchased three years ago has up to date suffered no loss in value because of obsolescence, although something may have been set aside each year to provide for anticipated obsolescence.

Many blunders are made in the treatment of equipment which is in some degree obsolete as if its obsolescence were complete, and in some instances serious waste results therefrom. In particular, if a company is prosperous there is the temptation to dispose of old equipment at a sacrifice in favor of the latest models, although analysis would show that as economic earning units, the old still possessed a substantial value. A street car, for instance, may be heavier than the most modern type and so require more current for operation as well as more time in starting and stopping than does the most modern car, but this is by no means equivalent to saying that the old car is worthless. A carefully conducted series of tests would disclose the extra current required and hence its cost, the extra time of starting and stopping and hence the losses involved therein; and the sum of all such annual losses capitalized for the anticipated remaining life of the car represents the loss in value due to obsolescence. Not until such capitalized loss equals the value which the car would have if free from obsolescence can the car be said to be wholly depreciated. Furthermore attention must be given to the service in which the car is used, for if it is on long runs with infrequent stops, the time lost in starting and stopping may become wholly insignificant; and if a car is used only on special occasions to carry a part of peak load traffic, its extra power consumption is a matter of little importance. The study of such problems deserves more attention than it has received.

Retail Cost of Food

The U. S. Department of Labor, through the Bureau of Labor Statistics, has completed the compilations showing changes in the retail cost of food in 20 of the 51 cities included in the Bureau's report.

During the month from Aug. 15, 1923 to Sept. 15, 1923, 18 of the 20 cities showed increases as follows: Los Angeles and St. Louis, 4 per cent; Baltimore, Fall River, New Haven, and New Orleans, 3 per cent; Chicago, Kansas City, Norfolk, Providence, Richmond, Rochester, and St. Paul, 2 per cent; Houston, Indianapolis, Jacksonville, Savannah and Washington, D. C., 1 per cent; and Portland, Me. showed a decrease of less than five-tenths of 1 per cent; Butte showed no change during the month.

For the year period, Sept. 15, 1922 to Sept. 15, 1923, all twenty of the cities showed increases as follows: Indianapolis, 10 per cent; Chicago and Baltimore, 9 per cent; Fall River and New Haven, 8 per cent; Norfolk, Providence, Rochester and Washington, D. C., 7 per cent; Richmond, St. Louis, St. Paul, and Savannah, 6 per cent; Jacksonville, Kansas City, Los Angeles, and Portland, Me., 5 per cent; Butte, Houston, and New Orleans, 4 per cent.

As compared with the average cost in the year 1913, the retail cost of food on Sept. 15, 1923 was 59 per cent higher in Richmond; 58 per cent in Washington, D. C., 57 per cent in Chicago, Baltimore, and Providence; 53 per cent in Fall River and New Haven; 48 per cent in St. Louis; 47 per cent in Indianapolis; 45 per cent in New Orleans; 43 per cent in Los Angeles; and 40 per cent in Jacksonville and Kansas City. Prices were not obtained from Butte, Houston, Norfolk, Portland, Me., Rochester, St. Paul, and Savannah in 1913, hence no comparison for the 10-year perior can be given for these cities.

Rail Type Grade Crossing.—The Arizona State Highway Department, according to The Highway Magazine is using a type of railroad crossing on Tucson-Nogales state highway, consisting of steel railroad rails placed parallel to the railroad track, both between the tracks and on the outside for approximately 18 in. The rails are placed ball up and the interstices are filled with concrete.

Current Material Prices

Iron and Steel Prices

(From the Iron Age, Oct. 4, 1923)

Prices as of Oct. 2, f. o. b. Pittsburgh:

Open hearth rails, heavy, per gross, ton	$43.00
Light rails (25-45 lb. section), per 100 lb.	$2.15 to 2.25
Track spikes, 9/16 in. and larger base, per 100 lb.	3.15
Track spikes, ½ in., 7/16 in. and ⅜ in., 100 lb.	$3.15 to 3.50
Track spikes, 5/16 in.	3.15 to 3.50
Spikes, boat and barge, base, per 100 lb.	3.50
Track bolts, ¾ in. and larger, base, per 100 lb.	$4.00 to 4.25
Track bolts, ½ in. and ⅝ in., base, per 100 lb.	$5.00 to 5.50
Tie plates, per 100 lb.	2.55 to 2.60
Angle bars, base, per lb.	2.75

Finished Iron and Steel

	Per lb. to large buyers. Cents
Iron bars, Philadelphia	2.67
Iron bars, Chicago	2.35
Steel bars, Pittsburgh	2.40
Steel bars, Chicago	2.50
Steel bars, New York	2.74
Tank plates, Pittsburgh	2.50
Tank plates, Chicago	2.60
Tank plates, New York	2.84
Beams, Pittsburgh	2.50
Beams, Chicago	2.60
Beams, New York	2.84
Steel hoops, Pittsburgh	3.00

Freight Rates

All rail freight rates from Pittsburgh on domestic shipments of finished iron and steel products, in carload lots, to points named, per 100 lb., are as follows:

Philadelphia	$0.32
Baltimore	0.31
New York	0.34
Boston	0.365
Buffalo	0.265
Cleveland	0.215
Cleveland, Youngstown, comb.	0.19
Detroit	0.29
Cincinnati	0.29
Indianapolis	0.31
Chicago	0.34
St. Louis	0.43
Kansas City	0.735
Kansas City (pipe)	0.705
St. Paul	0.60
Omaha	0.735
Omaha (pipe)	0.705
Denver	1.27
Denver (pipe)	1.215
Pacific Coast	1.34
Pacific Coast, ship plates	1.20
Birmingham	0.58
Memphis	0.56
Jacksonville, all rail	0.70
Jacksonville, rail and water	0.415
New Orleans	0.67

Rails and Track Supplies at Chicago

Standard Bessemer and open-hearth rails, $43; light rails, rolled steel, 2.25c, f. o. b. makers' mills.

Standard railroad spikes, 3.25c mill; track bolts with square nuts, 4.25c mill; iron tie plates, 2.85c mill; steel tie plates, 2.60c, f. o. b. mill; angle bars, 2.75c, f. o. b. mill.

Jobbers quote standard spikes out of warehouse at 3.90c base and track bolts, 4.90c base.

Cement Prices

Recent quotations, per bbl., in carload lots, exclusive of package:

Pittsburgh	$2.24
Cincinnati	2.54
Detroit	2.50
Chicago	2.20
Milwaukee	2.37
Duluth	2.25
Minneapolis	2.50
Davenport, Ia.	2.48

Cross Tie and Lumber Prices

(From Lumber, Oct. 5, 1923)

White Oak Ties

F. o. b. cars, Chicago, Oct. 3.

No. 5—7x9x8	$1.80
No. 4—7x8x8	1.65
No. 3—6x8x8	1.50
No. 2—6x7x8	1.40
No. 1—6x8x8	1.30

Red oak ties, 10@15c less than white oak. Sap pine and sap cypress, 10c less than red oak.

White oak switch-ties, per M. ft.	$55 to $58
Red Oak switch-ties, per M. ft.	49 to 51

White Oak Ties

F. o. b. cars, St. Louis, Oct. 3.

No. 5—7x9x8	$1.60
No. 4—7x8x8	1.47
No. 3—6x8x8	1.30
No. 2—6x7x8	1.20
No. 1—6x6x8	1.10

Red oak ties, 10c per tie less than white oak prices. Heart pine and heart cypress, same prices as red oak. Sap pine and sap cypress, 25c less than white oak.

White oak switch ties, per M. ft.	$48.00
Red oak switch ties, per M. ft.	45.00

Bridge and crossing plank, same prices as switch ties.

Market Prices of Lumber

	Flooring, 1x4, No. 1 common	2x4, 16 ft., No. 1 common	Timbers, 6x6	Timbers, 12x12
Boston—Yel. Pine	.....	.....	$55@57.00	$63.00@66.00
New York—Yel. Pine	$57.00	$45.75	50@52.00	57.50@63.00
Buffalo—Yel. Pine	53.00	.....	.....	47.50@51.50
Chicago—Yel. Pine	45.00	.....	.....	51.00
St. Louis—Yel. Pine	43.00	.....	.....	41.50@42.50
Seattle, Wash.—D. Fir	56.00	20.50	28.00	25.00

Southern Mill Prices

	Flooring, 1x4, No. 1 flat	2x4, 16 ft., No. 1	Timbers, No. 1, 4x4 to 8x8	Timbers, No. 1, 3x12 to 12x12
Alexandria—So. Pine	$38.00	$26.00	.....	.....
Birmingham—So. Pine	38.78	.....	.....	.....
Hattiesburg—So. Pine	39.73	26.71	$28.50	.....
Kansas City—So. Pine	.....	25.72	28.84	39.87

The Dirt Mover's Day

By E. F. STEVENS,
Of Stevens Bros., Contractors, St. Paul, Minn.

A one machine outfit
Got a good job
Thirty miles out
Not troubled by a mob.

Tote road rougher than
The road to hell
Not paved with good intentions
Which was just as well.

For the six up skinner
Will get there soon
If he doesn't lay off
A hittin' up the "moon."

Machine running good
In every way
But the belt got ripped
And tore up today.

Punched full of holes
We paid the price
For guaranteed belting
But the dealers say it's mice.

Had a little hail storm
Lasted thirty minutes
Cat, machine and wagons
Skidded 'round like crickets.

Bull wheel slipping
Disc gummed tight
Dogs in the rachet plates
Never did seem right.

Broke a short shaft
Also a box
When the cat skinner
Overlooked a few rocks.

Followed this delay up
Jumped the tracks
Spent a couple of hours
Using men and jacks.

Machine man left us
Too much booze
Said he couldn't stand it
Without new shoes.

Heard them hollering
On the dump
A team got under water
Nothing showing but a rump.

Heave horse got winded
By the heat
Sent the bay mares into camp
With sore front feet.

Blacksmith out of coal
Shoes all gone
Barn man and cripples rest
Until tomorrow morn.

Cracked two wagon poles
And one wheel
Wagon skinner tumbled off
Run over on the heel.

Getting 'long toward six o'clock
Outfit standing still
Gasoline tank empty
Tank's on five mile hill.

Pretty much hay wire
All day long
But a damn good outfit
Luck's all wrong.

Called "all off" for chuck
Started for camp
Couldn't make the Ford go
Dry cells damp.

Triangle was ringing
Walked two miles
But came out from that camp shack
All covered with smiles.

Played a game of poker
Cuffed the stock
Had a little dice game
To bed at ten o'clock.

Thinking 'bout the troubles
An outfit brings
When a baby cyclone hit us
And the camp took wings.

Finally cut the stock loose
Slept in the hay
Cold and wet and shivering
'Till the sun brought day.

Mighty nice June morning
Western prairie sort
Can't see why the engineers
Cut estimates so short.

Placing Concrete with Belt Conveyor

In building concrete retaining walls for the Illinois Central Railway's new lake front improvements at Chicago, the Underground Construction Co., is using with much success a belt conveyor for placing the concrete.

The conveyor is a standard Barber-Greene portable belt conveyor, with gasoline engine. The machine has been detached from its truck, however, and mounted on the mixer by means of two bails. This mounting allows the operator to swing the conveyor just as he would a gravity chute.

The mixer is mounted partly on solid ground and partly on staging, as can be seen in Fig. 1. In order to chute the wet concrete by gravity it would have been necessary to mount the mixer completely on staging, which would have been costly and impractical. Four men with buggies were tried, but they proved slow and also expensive, when compared with the conveyor which replaced them. The present method with the conveyor has proved entirely practical, less expensive, and much faster.

The only change made on the belt to enable it to handle wet concrete properly was the addition of a squeegee made of two pieces of rubber held between two pieces of angle iron across the belt. Baffle plates slanted in any desired direction prevented the mix from separating and directed the discharge.

Fig. 1.—Arrangement of Conveyor for Handling Concrete.

One form contains on the average 100 cu. yds. of concrete of a mix 1-2-4. Panels, two or three in number, to lend a somewhat ornamental effect to the wall on the railroad side, are built into the forms and slightly complicates the pouring. However, since putting the conveyor on the job, the contractor has been averaging two forms, 200 cu. yds.—per day, with a maximum of 250 cu. yds. poured in 8 hours.

The concrete is brought up in eight layers, wooden chutes with drop bottoms being placed inside the form to accomplish this. The conveyor discharges in sequence to all of them and

the concrete is distributed by regulating the drop bottoms.

Fig. 2 shows a general view of the job. Bins for sand and stone are loaded by a crane from stock piles. The bin gates are tended by one man. Several cars are kept ready at all times. Two cars at a time are drawn to the mixer by a horse. The platform beside the skip is moved along with the mixer.

Fig. 2.—General View of Job, Showing Sand, Stone and Cement Storage and Portion of Retaining Wall.

Wind Direction Plays Big Part in Laying Out Cities

Washington, D. C., which was laid out in 1789 by Maj. Pierre Charles L'Enfant, is an example of the advantages to be obtained from planning cities with the future well in mind. The city of Springfield, Ill., is about to adopt a city plan, contemplating for the future city, among other features, a union railroad station, an industrial district, the creation of a lake in the valley of the Sangamon River, and a civic center.

The industrial zone is to be located in the extreme northeast part of the city. Attention was given to the source of local water supply, proximity to railroads and terminals, housing conditions, and available sites for industrial plants. An important consideration, however, in choosing this location was the prevailing wind direction. It is always preferable that smoke, gases, and noise should blow away from, not over, the residential parts of the city.

The 44-year weather record of the Weather Bureau of the United States Department of Agriculture for Springfield shows that the prevailing wind direction is from the northwest in January and February and from the south during all the other months. It was clearly indicated that by locating the industrial zone in the northeast smoke-bearing winds would blow over the city but a small part of the time.

Similar plans have been laid out for several other cities. Local conditions sometimes make is impossible to place the residential section to the windward of the industrial zone, but in future city planning wind direction will no doubt be given due weight. The Weather Bureau has records extending over long periods for many regions to aid in determining the direction of prevailing winds.

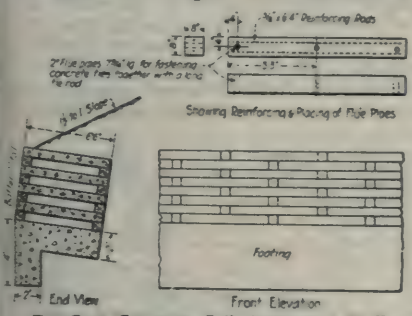
Oil Cloth Casing for Underwater Blasting

In demolishing 200 piers of the old military bridge over Rock River at Rockford, Ill. the sticks of dynamite were wrapped in oilcloth and tied to the piers under water. According to Successful Methods the sacks were made of cheap table oilcloth, sewed with oil side in.

Retaining Wall Construction of C. & N. W. Ry. at Milwaukee

Interesting Types of Pre-Cast Walls Being Built for Layton Park Track Depression Scheme

In connection with its grade crossing elimination scheme at Layton Park Station, Milwaukee, Wis., the Chicago & Northwestern Ry. is constructing a large amount of heavy retaining wall. Three type of wall are being used, two of which are unique. The method of

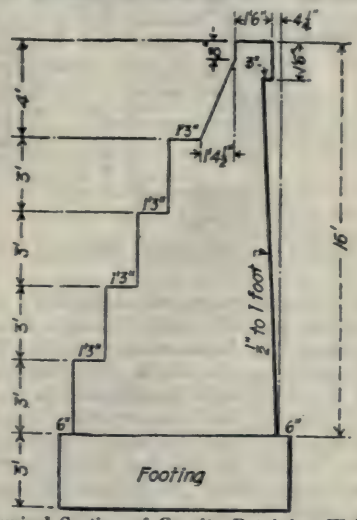


Pre-Cast Concrete Crib Retaining Wall, Layton Park Track Depression.

constructing some of the gravity also is unique. We are indebted to the Railway Review for the following details:

There are 25 industrial plants in the territory affected by the work, and a number of them have permanent buildings abutting directly on the right of way at the point where the depression is greatest. The material at this point is yellow clay, gravel, sand, and some blue clay in well-defined strata, and is generally of unstable character. Through this section is was not possible to complete the excavation and afterwards build the retaining walls, as the safety of the buildings could not be assured without unreasonable expense. It was therefore determined to build the retaining wall which is of heavy gravity section ahead of the steam shovel. Because, in a number of cases, the building line is coincident with the right of way line, it was necessary to locate the wall wholly on the company's property. On account of the unstable character of the underlying material, unusually heavy bracing was required, and to avoid any possibility of damage to the adjacent structures the lateral braces were not removed during the process of depositing the concrete, but were left embedded in the wall. To avoid the disfigurement of the finished wall, recesses 18 in. deep were left at each tier of braces. After the wall is constructed and back filling is in place these timbers will be cut off at the inner face of the recess and the recess filled with concrete. The tiers of braces were spacd 6 ft. 6 in. apart. There are 2,000 lin, ft. of this wall measuring 24 ft. above the footing.

Concrete Plant and Equipment.—In view of the fact that the retaining walls and bridge abutments were located at such widely separated points and over the full length of the work, and because of the not have been economical or efficient. Mixing plants of the usual type and with the usual organization were located adjacent to the various structures, and moved as needed. Five Smith mixers of capacities ranging up to 1 cu. yd. capacity are in use on the work. Universal



Typical Section of Gravity Retaining Wall.

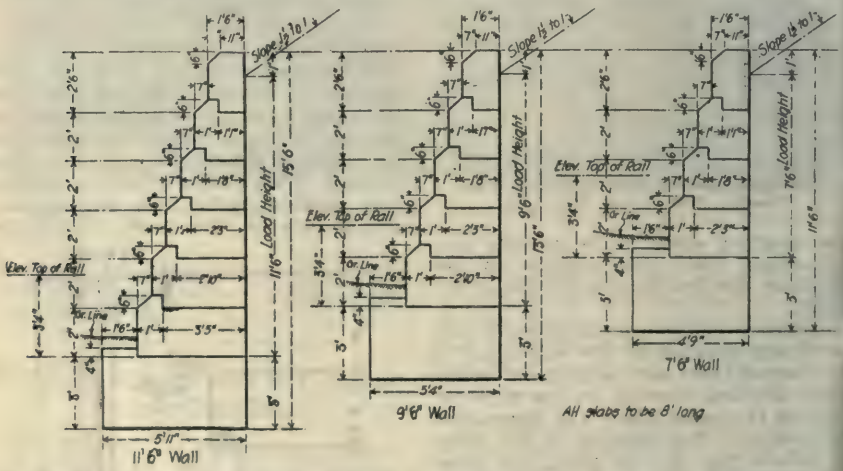
Portland cement and Atlas cement have been used throughout except for small quantities of other brands when deliveries were not prompt.

For foundation excavation a combination of Osgood shovel fitted with a clamshell bucket, another combination

shovel similarly equipped, and a Keystone digger are in use, and a Thew excavator is expected to be put in service in a few days. A Bay City track driver furnished by the railroad has driven all false-work, and a "jim crow" bridge derrick is used to handle track material and to set the precast retaining wall sections.

Precast Construction for Retaining Walls.—Between Midland Ave. and 8th Ave., a distance of 1,200 ft., a unique form of retaining wall construction is used. This wall is made up of precast blocks of concrete 8 ft. in length. Three heights are used by simply leaving out the lower course, or courses. The majority of these blocks were cast by company forces in the material yard maintained by the railroad at 46th and Chicago Aves., Chicago. The balance were cast by the contractor on the work. The footings for this wall were constructed in place and one of the construction tracks thrown over near the wall. The blacks were placed by the jim crow derrick mentioned above. All horizontal joints are sealed by bedding the blocks in an asbestos fiber filled asphalt, which is spread hot just before setting the block. No figures are yet available as to comparative cost of this type of wall and the gravity sections of similar height, but under favorable conditions of placing it is believed to be cheaper, and under conditions which obtained at this point there was less interference with the work.

Precast Crib Retaining Wall.—Along the south side of the elevation in the vicinity of Mitchell yard a cribbed retaining wall of precast concrete units is under construction. The units are 8 in. by 8 in. in section and 6 ft. 6 in. long. The face of the wall is built solid, while the back and the ties are of open crib construction. The wall will be from 5 ft. to 12 ft. in height, and of a uniform width of 6 ft. 6 in. As in the case of the other type of precast wall, the footing was constructed in place and the wall built up on it. The units are tied together by means of short pieces of gas pipe imbedded in the concrete and which fit into a socket provided in the underside of each unit. The separate units can be handled by hand, and the wall is built up as the fill is raised. This is done partly to permit the earth to run into and fill the pockets, and partly to make the erection easier.



Sections of Pre-Cast Gravity Retaining Wall, Layton Park Track Depression, C. & N. W. Ry.

A total of 9,700 ft. of retaining wall is required by the railroad. Of this 1,200 ft. is of the precast blocks, 2,000 of the precast crib type, and the balance is of gravity section. The city and the towns of Lake and Greenfield are constructing a total of 2,000 ft. of retaining wall, all of which is of the gravity type. For the railroad part of the work 28,000 cu. yd. of concrete are required for retaining walls and bridges.

Maintenance of Light Traffic Branch Lines

Committee Report Presented Sept. 19 at 41st Annual Convention of Roadmasters and Maintenance of Way Association

The maintenance of branch line tracks is of greater importance than most railroad managements realize. Few of the higher officers pass over these lines more than once or twice a year and the maintenance of these branch lines is left to the division officers.

Branch lines should be designated as A, B, and C, according to the volume of traffic.

Class A 11 to 16 Train Lines.—Class A branch lines include those with from seven to ten freight trains and four to six passenger trains a day, the freight trains operating at speed of 30 to 35 miles and passenger trains at 40 to 45 miles per hour. Class A lines have no limits as to weight of motive power, or of trains that can be handled. Locomotives may weigh from 125,000 lb. to 392,000 lb. While the cars of today are increasing in weight and are now stenciled for loads up to 150,000 lb. with a total weight of 193,000 lb., these cars used on primarily ore and coal carrying lines and for the handling of stone, sand and oil field supplies.

Lines of this type should be laid, where possible, with new 90 lb. rail, second quality; or if this is not obtainable, they should be laid with good selected second hand 90-lb. rail, sawed or rerolled. New angle bars should be used when laying this type of rail because of the marked saving in the expense of maintaining the track after the rail is laid. Some managements have concluded that when rail of this type is laid, no ballast is needed or that the number of cross ties can be decreased materially.

We should have 20 first class treated ties under a 33-ft. rail and if they are of soft wood they should be plated to carry the train loads. No less than 8 to 10 in. of ballast should be used. If gravel can be procured a bed of at least 10 in. should be put under the ties, and where it cannot be procured first class cinders should be used for surfacing and to keep the track up out of the mud. Too little stress has been placed on the necessity of putting enough ballast under the track to keep it from pumping mud and becoming rough.

On descending grades where the rail creeps, a sufficient number of rail anchors should be applied to hold the rail from creeping and thereby avoid the unnecessary expense of spacing the ties under the joints each year. It is very expensive to have to space the ties each year where the rail creeps, to say nothing of having to drive the rail back sometimes three and four miles to get the proper expansion and to keep from cutting your rail.

The turnouts should be laid with the same weight of rail as the main track to the clearance point. They should be equipped with the proper braces and fastenings so that they will stay in place. All guard rails should be fastened to the running rails with heel blocks and clamps. In most instances enough good second hand tie plates can be picked up where new rail and tie plates have been laid on the main line to take care of this condition. A tie plate will add from three to four years to the life and will hold the rail to the proper cant so the wheel tread will cover its full face.

This class of line should have at least six men per section during the summer with sections not to exceed 6 miles in length.

Class B 8 Train Lines.—Class B branch lines handle heavy loads with three or four freight trains, two passenger trains and two locals each way daily. A line of this character should be laid with good second hand 80 lb. or 85 lb. rail that has been taken out of the main track, where it can possibly be procured. Where there are gravel pits on the line it should have at least 8 in. of gravel ballast under the ties and be dressed up to standard. It should have at least 20 ties to a 33-ft. rail. If the ties are treated they should be tie plated and at least all curves on such a line should be tie plated. Second hand tie plates should be taken from the main line where available. If not, new tie plates should be applied. Where the heavy traffic on such lines is in one direction, rail anchors should be applied to keep the rails from creeping.

On a line that has come to the attention of the committee where 52 lb.

rails were relaid with 89 lb. rails, the management thought the track required no ballast after the heavier rail was laid. In spite of the fact that section forces were increased to nine or ten men to the section, the line could not be kept in surface and during the wet season derailment after derailment was caused by speed or poor surface or both. Finally the line was ballasted with good gravel and the trouble ended.

Class C 5 Train Lines.—Class C lines carry very light power with two passenger trains, two local trains and possibly a pick-up train a day. Such lines are frequently laid with 52 lb., 56 lb. and 60 lb. rails. Although the traffic is light, the light rails and poor ballast invite derailments. Such lines should be laid with relay 80 lb. rail to save maintenance and avoid derailments.

Although local trains will handle only 18 or 20 cars, they will include hopper gondola cars of coal weighing as much as 185,000 lb. Such cars will cause the light rails to turn over and cut down into the track ties and in the course of six or seven years soft ties are about cut through and must be renewed. The rail has become kinked, surface bent or line bent on account of the poor ballast and the expense of maintaining such a track is heavy as the section forces will have to pick up the track constantly to keep it in riding condition and to keep the trains on the rails.

On the other hand, good second-hand 80-lb. rail laid on 16 ties to a 30-ft. rail would save 320 ties to the mile. Also about 9 per cent of the ties in the track are changed out every 6 or 7 years on account of being cut almost in two with the light rail and the elimination of this form of failure would add four years of life to 288 ties in the track.

We have a record on such a line where four or five derailments occurred which required the wrecker to rerail the cars at a cost of about $840 for the wrecking outfit. With heavier rail the maintenance force on such sections could be cut from six to four men which would mean an annual saving of about $950 a section.

The replacement of 52 lb. rail with 80 lb. rail adds 44 tons of steel to the mile. This, at $22.50 a ton, would mean an expenditure of $990 per mile.

We should not overlook the fact that the railroads are constantly placing heavier power and equipment on their main lines and transferring their lighter equipment to branch lines and that the maintenance of way department is not keeping pace with the transportation and mechanical departments in the construction of its tracks on these branch lines.

During the summer a section foreman should spend at least one day a week in going over his section, picking up low spots and lining any portion of the track that may need attention. During the winter period of heavy storms when snow plows pass over the line, a foreman should be allowed enough men to clean the snow away quickly, taking them off as soon as the track is clear.

Sections on Class "C" branch lines should not be over eight miles long and should be equipped with motor cars.

During the winter when cinders are plentiful at the roundhouse, they should be taken to the branch lines and a few extra laborers given to the sections to unload them, until the sections are covered with sufficient cinders for a raise of at least 6 in. By keeping this practice up from year to year it will be only a short time until such branch lines are entirely cindered. This will result in great economy in the cutting of grass and the mowing of weeds along the ballast line, as cinders will keep down the weeds and grass growth occurring along the track.

Track of this kind can be handled during the summer with three or four section laborers if there are not too many ties to be applied, or too much surfacing to be done. In the winter two men with the foreman can take care of such tracks.

On such branch lines, all ditching should be done with a mechanical ditching device and where this cannot be done, teams with scrapers should be used to clean out ditches and shape them for the winter. During the month of October, section forces should have completed the summer work so that they can see that all fences are in proper shape for the turning in of stock, set up snow fences to take care of the winter storms and do such light cleaning of ditches as may be necessary, such as burning them out and trimming them up so there will be a free flow of water. They should then go over their sections and drive down the spikes and tighten bolts.

The Maintenance of Large Yards and Yard Tracks

Committee Report Presented Sept. 18 at 41st Annual Convention of the Roadmasters and Maintenance of Way Association

The maintenance of large yards and yard tracks covers a much wider scope of activities than ordinary main track work, because of the many different conditions that affect it. Among these are the constant interruption by yard operations, the many different kinds of tracks to be maintained, the kinds of loads passing through the yard in different directions, the greater number of heavier loads moving over one part of the layout than another, the weight of the engines used and the character of the sub-grade on which the yard is constructed.

Effect of Improper Design.—The problems created by the improper design of yard layouts as well as initial construction done on a temporary basis, particularly with respect to drainage, exert a very direct influence on the economical maintenance of the yard after it has been put in service, and, while this report does not deal directly with this question, it is one that is later reflected very considerably in traffic interruptions, as well as maintenance costs, and should be studied very carefully before money is appropriated and expended for construction. Such conditions occur most frequently where additional yards are developed on limited areas to take care of increasing business, and where construction work is rushed through to put the tracks in service at the earliest possible time, on account of an already existing need.

Development of Maintenance Force.—A properly balanced maintenance force, by sections, should be developed on an equated mileage basis, taking into consideration not only the mileage of the different classes of tracks, the number of switches and the drainage conditions involved, but also the special operating conditions affecting each section, so that they are all as nearly equal as possible in the amount of work to be done.

Nothing is more discouraging to a foreman than to be overloaded with duties, whether he may have more force or not, while his neighbor has fewer responsibilities and less work with the same compensation. A careful study of the maintenance needs, together with the available material, should also be made, in order to place each man in the place where he will be most useful and at the same time, if possible, best satisfied with respect to living conditions for his family and himself.

While there is no maintenance work that suffers more interruptions and drawbacks than yard work, and no kind as difficult to plan and carry out as planned, the planning of work by seasons, and close supervision to assist in its being carried out as nearly as possible in accordance with the schedule, is very necessary.

How to Prepare a Program.—There should at all times be a clearly defined plan to follow with an understanding as to the next most important task, in case the yard business prevents the most important one from being done at the time. One method of preparing such a program which has been used with distinct advantage over some other methods, is for the supervisor to cover each section with the foreman in charge about the first of the year, or at a convenient time before spring when the tracks are clear of snow, and make a careful study of the maintenance needs of the section on the ground, after which a schedule is prepared of the different stretches of tracks to be worked during the year, in the order of their importance. This schedule should show the estimated amounts of material needed for each stretch of track. The supervisor should give a copy of this schedule to the foreman and retain a copy for his use.

This work should not be delegated to anyone, but should be handled personally by the supervisor and the section foreman. Such a program should be prepared only after very careful study and discussion of the advisability of the order of preference in carrying out the work. Of course, no such schedule, particularly one of yard maintenance, can be followed to the letter. Many things develop to interfere with such a definite plan, but, notwithstanding this, the increase in the volume of work accomplished during a season with such a carefully mapped program is

very marked. This is not only a decided advantage to the foreman, but probably even more so to the supervisor, as he is familiarized with all of the detail problems of his year's work, as no other method will enable him to be. He is also able to distribute materials to much better advantage so as to keep all of his section groups working without lost motion, particularly if there is a shortage of any kind, or if there are conditions which do not permit of the proper kinds of material coming to him in the most desirable order.

Cutting Down the "Paper" Work.—Another very important question in promoting yard maintenance is to eliminate as much paper work by the foreman as possible, to enable him to remain with his gang. This is especially important, as yard work involves many reports and a foreman is frequently overloaded with them, to the detriment of the direct supervision of his work. His reports should be cut down to such kinds as keeping time, preparing reports of accidents due to track conditions and making monthly reports of gage, line and surface conditions, etc., for which he is directly responsible. All other current reports should be handled by some one delegated by the supervisor, who can handle this work for several sections, or for a whole yard of moderate size.

The Material Yard and Its Equipment.—Materials should not be scattered through the yard, except a small supply for emergencies, but should be located in a material yard, as centrally located as possible, with supporting tracks so that the unloading and loading will not be interfered with by the yard operations.

Rails and other heavier materials should be handled by small derricks or rail loaders, and only distributed for use when needed. They should be piled neatly by kinds, and plainly marked so that no errors will be made in distribution or in the preparation of material reports.

Small parts, threaded and insulated materials, should be kept under cover at the same location, so that while the heavier materials are being loaded, preferably with a derrick, a part of the gang can be assembling the bolts, splices, switch plates, and other materials it is necessary to handle at the time.

It is also profitable to have an air line to the material yard, so that a maintenance of way shop can be maintained for reclamation and repair work in conjunction with an oxyacetylene outfit.

A small sawmill can also be operated to excellent advantage in the manufacture of suitable lumber and wood paving blocks from solid parts of old switch ties; old telegraph poles and other suitable discarded timber; also a concrete mixer for use in preparing concrete for curbing, foundations for small buildings, etc., or for mixing cold patch tar products for road crossings and platforms, if the volume of that kind of work is found to warrant its installation.

A small maintenance of way storehouse, either in charge of the supervisor or the local shop storekeeper, with about a two months' supply of materials on hand is a distinct advantage, all materials coming to the yard passing through the storehouse from the division storekeeper. The small surplus will save delays in maintenance work, and the system of having the foremen receive their materials from the local storekeeper will eliminate the extra work of breaking up the supply into so many packages and shipments, and avoid losses in transit and a very considerable amount of clerical work.

Scrap should be systematically assembled into scrap boxes that can be picked up and dumped into cars by means of a small derrick equipped with a magnet or a rail loader.

Special instructions that will best apply for each particular yard should be prepared for cleaning up scrap and also for keeping the yards clean of rubbish, coal, etc. This work varies in volume according to the commodities that pass through the yard, and is particularly troublesome with high loads in open top cars, such as coal and coke thrown back in the cars, keeping the territory fully covered and cleaned each day. The matter of policing yards is most important, and deserves more consideration than it frequently gets, not only from the standpoint of good house keeping, but of safety as well.

Rails For Yard Tracks.—The matter of using heavier rails in yards and tracks is one that is frequently neglected, on account of a considered existing need of such material on other parts of the railroad. This, in our opinion, is often done at a tremendous loss in maintenance. Rails

in all yard tracks should originally be at least of 85-lb. section. First or second-class fit rails are satisfactory, the first-class rail to be used on the more important running tracks and ladders. This plan, if followed, will very materially reduce the cost of ties, and line and surfacing, and, in every case, we feel that it will more than equal the cost of the additional weight of rail applied. With our present types of coal cars, a large per cent of which weigh 210,000 lb., and the heavy switching locomotives, this matter deserves most careful consideration.

Details Worthy of Special Consideration.—There are many details in maintenance which are being followed to excellent advantage on many railroads for road work, but are given less consideration in yard maintenance, some of which are suggested as worthy of special consideration as follows:

Adequate drainage.

Application of switch point guard rails ahead of the sharper leads.

Application of rail anchors where needed.

Tie plating all main tracks, engine tracks, and ladder tracks throughout, and all other tracks where traffic develops mechanical wear on ties.

Milling of stock rails to increase the life of switch points.

Carefully supervised joint maintenance.

Careful distribution of ties and rail, taking into consideration the tonnage handled over the different tracks, together with the subgrade conditions.

Monthly reports of track condition, as to gage, line, surface, etc., made by the foreman after careful personal inspections.

Careful study and adoption of labor saving devices.

The Importance of Co-operation.—One of the most important factors in getting results in yard work is co-operation. Allotments of labor and material mean far less, and suggestions for good practices and their application are less effective if there is no real co-operative spirit between the supervisor and his forces as well as between the maintenance of way department and the transportation people.

The work to be done that will necessitate the absolute use of a track for a few hours or more, should be anticipated sufficiently in advance by the foreman or supervisor to enable the yardmaster to plan accordingly so as to help him out.

On the other hand, in making track repairs, no materials should be left lying between the tracks of yards or adjacent to any tracks where they may cause injury or inconvenience to trainmen, especially over night, and all ballast should be leveled, particularly in inter-track spaces.

A good plan is to take night trips through the more poorly lighted portions of the yard with the foreman frequently. This will impress him more forcibly than letters regarding the real necessity of keeping the yard free of surplus materials and thoroughly clear of obstructions.

The Relations of Supervisor and Foremen.—Lastly, we consider as important as inter-departmental co-operation, the spirit of helpfulness to be shown at all times by the supervisor to the foremen. Keep out on the job with them as much as possible. Not only plan their work by seasons, but study their daily problems and help them to overcome them. Keep them supplied with the necessary materials to do their work as nearly as you can and help them to get their work done by giving them the benefit of your experience as well as by co-operating with the other departments. It is not only a supervisor's duty to do this, but he should manifest an interest in the personal side of the foreman's life, to show him that supervisory forces are created to be helpful, with their better judgment and more varied experiences, rather than to be merely "bosses" as they may sometimes designate themselves.

The policy of giving friendly advice in matters that do or do not deal directly with the foreman's work never fails to make him a better foreman, and always makes the work, however difficult or trying it may be, go better. Do not ever lose sight of the fact that a good foreman is just as good at sizing up human nature as you are, and while he may not be one hundred per cent in all the requirements as you see them, he is more sensitive, because of these shortcomings. It is up to the supervisor to get results with the material at hand, and by showing a real human spirit of helpfulness, he can develop a man that is frequently far beyond your expectations.

Railroad organizations, which must necessarily be stable and lasting, are after all built on loyalty, and loyalty is developed only by co-operation and helpfulness, which should manifest themselves at all times. There is no other sub-officer more favorably situated to help his company and the company's organization in this respect than a track supervisor, and we feel that such a policy is ever more necessary for stimulating maintenance activities in yard work, because of its many and perplexing problems which are being constantly added to by heavier loads, and the public's ever increasing demand for better and prompter service.

Construction of Street Railway Tracks in Paved Street

Discussion Before Conference at Engineers Club of Philadelphia

By R. C. CRAM

Engineer, Surface Roadway, Brooklyn (N. Y.) Rapid Transit Co.

Some years ago, I had the honor of being chairman of a committee of the American Electric Railway Engineering Association when it took up this very important subject, the question of the proper foundation for tracks in paved streets.

Factors Influencing Foundations.—In the first place, it must be realized that tracks must be designed to suit the conditions in which they are to be laid. For the purpose of getting it into the record of this meeting and reaching as many as possible of those who are interested in this subject, I would like to just read the factors which we discovered as influencing the foundation for tracks in streets. In the report which we made there were twelve of them: Character of subsoil; bearing power of soil; drainage of subsoils; effect on electrolysis; forms of sub-structure; live and dead loads carried; form of track superstructure; pavement; speed of trains; street improvements; subsurface structures; street and car traffic.

There is one item in there which divides itself into at least five more. And that is the term, "Form of track superstructure." Usually divided into —ties, kind of tie; the rail, type and position; rail fastenings; rail joints; and pavement.

When you come to think of it, it is quite a problem to combine so many conditions and materials in that one structure and to have each one of those materials behave in the way that you hope it will.

The track is very much like a building in a number of respects,—made up of steel, stone, wood, cement, and each one of those materials has certain characteristics. When we come to combine them in a building, we do certain things with them. When we come to combine them in a track or pavement, we do other things with them. There is quite a ramification involved in considering how to put all these things together to make them into a harmonious whole.

Bearing Power of Soils.—Perhaps, the place, then, where you must start is in the subsoil. That is where you start when you build a building. That is where you lay your track. Evidently, the municipal engineer and the street railway engineer have not been close enough together in giving proper thought to the subsoil.

Investigation of the bearing power of soils in our city streets, not merely at the surface, but slightly below it, for instance, as an indication of what the soils may do,—the water retaining quality of soil,—was made a long while ago, and I quote from the report of the American Railway Engineering Association on some experiments back in 1884 by a Professor Shubler. He found out that 100 lb. of dry soil would retain the following weights of water which would not flow off: Pure clay, 70 lb.; clay loam, 50 lb.; loamy soil, 40 lb.; sand, 25 lb.

Right there, then, are the soils that we meet in our streets,—sand allowing the water to flow off most readily and pure clay retaining water the greatest length of time or in the greatest amount. The engineer must pay attention to the soil in which he is going to build.

It is rather remarkable that we are able in this day and generation, in view of the fact that the street railway business is practically only 30 years old, to build tracks and maintain them as well as we do. The science is young when you realize that the American Railway Engineering Association in conjunction with the American Society of Civil Engineers, but recently announced what none of us really have known before, and have given us the proof of the fact, that a track is an elastic structure and is subject to the law known as Hooke's

Law, that whenever a body is subjected to an external force, a stress and accompanying deformation result.

Similarity of Steam and Street Railway Track.—A street railway track does not characteristically take on any shapes, different in its prime state from the steam railway track. I think that that fact should not be forgotten. We have to recognize the fact that there is an element of elasticity there; and the main point, then, is to control that and to make its influence felt in a way not to be damaging. Some of the points that have been brought out in this talk that we have had today show that we are getting closer together.

In a study made a few years ago, we found that something around 70 per cent of the electric railways in the United States use some form of ballast construction; 10 to 15 per cent of those answering the questionnaire stated that they usedt he natural soil or ballast; a much larger proportion use crushed stone or gravel; and a comparatively small portion used some form of what was designated as concrete ballast.

Most street railway tracks with any form of concrete ballast, as made in the past—I won't criticise too much present defects—were generally failures. In the city of what is now the Borough of Brooklyn, we have a sandy loam soil. Some places we have clay. The standard track construction authorized by the Bureau of Highways is a replica of the Brooklyn Rapid Transit Co. standard construction. Their design was made by the chief engineer, Herman Smith, after investigation in very many places. It is the right of every city, for the good of itself and the community and for the street railway company, to have the best possible track. The reason for that is because we have also to figure the burden of maintaining the pavement. There is absolutely no reason for us to consider the construction of poor tracks, because that only leads to needless expense in maintaining both the track and the pavement.

In Brooklyn we excavated to subgrade or slightly above it for the tie, encase the tie in concrete, pave generally with granite block. Latterly we have come to paving with sheet asphalt on concrete in direct contact with the rails.

Cost Comparison of Old and New Track.—We had occasion in 1922 to take up a steel-tie, concrete constructed track, which consisted of about 6 to 8 in. of concrete, encasing a 4 in. steel tie, spaced about 4 ft. on centers, which was very popular at the time the track was built. We started to reconstruct this job. The track was only 14 years old. It was on the busiest street in Brooklyn. The joints unfortunately were a kind of joint—one of our experiments, one of the reasons why that track went so fast. Why didn't we try to put new rails on the old foundation? We tried, figuratively. We laid out some sketches and designs to show what could be done, but unfortunately the track had settled about 2 in.; in some places, three. There was practically nothing in the line of pipes that would cause it to go down, except it naturally wanted to settle and it had been built over a subway. To put in new rails on that structure, would have been "some" job. We gave the proposition up, got our derrick cars and torches and concrete drill, cut the track up in sections, concrete and all and threw it away.

And in its place we put a simple wood-tie constructed track, with the American standard grooved girder rail, and paved with asphalt. The old track last 14 years. The type we have used in replacing it will not wear out of its own volition in that time. It is safe to say that it will last 20 years. I personally have hopes of 25 to possibly 30, but I am very safe in saying 20 years. It cost less to build proportionately, if we go back to the time of construction. The track that we had to take out cost $34,000. It cost $51,000 in 14 years to maintain that track; so that the track represented an expenditure of around $85,000. It only cost $50,000 or some such amount to rebuild the track, and the cost per foot for maintaining the old track per year, or rather the average annual cost figures something like 90 cts. per foot, which the average cost per year for most of our 7 in. track built since 1907 is around 10 cts. per foot per year. The results attained have been due to constant attention to details of track construction.

The problem of building suitable tracks on streets is one of great ramifications, one requiring the best minds in the industry; not alone in our industry but in the municipalities as well, and it will only be by co-operation that we will arrive at a satisfactory solution.

Forreston Gravel Plant of Illinois Central R. R.

New Washing, Screening and Crushing Plant Described in Paper Presented Sept. 24 Before Western Society of Engineers

By W. A. GELBACH,
Supervising Engineer W. J. Zitterell Co., Webster City, Ia.

A gravel washing screening and crushing plant, modern in all respects and unique in some respects, has recently been constructed by the Illinois Central Railway.

The plant is located in an extensive gravel pit owned by the railroad company and located on its old main line about 2½ miles north of Forreston, Ill., and about 11 miles south of Freeport.

View of Barge, Showing Suction End of Intake.

The Forreston gravel pit has been in use for many years. In fact, the railroad company began loading cars by hand in this pit 50 or more years ago, soon after this line was built. For about the last 30 years, cars have been loaded here by steam shovel. Gravel from this pit has been used very extensively by the railroad on its northern and western lines.

The Gravel Deposit.—The bank run of the gravel contains 20 per cent to 30 per cent of material above the 2½ in. size usually specified as maximum for ballast, and a great many of these boulders are too large to allow of placing under railroad tracks as ballast. When using the bank run of gravel as loaded by steam shovel, it was necessary, after loading and hauling this useless material to a job, to dispose of it in order to clear the right of way. This incurred an additional expense. Experience has also shown that clean ballast affords a great saving in the expense of weeding track.

The deposit of gravel lies from 30 ft. to 60 ft. below the level of the ground water and at some points as high as 90 ft. above it. Streams to the south and to the north of the deposit prevent excessive variation of the level of the ground water. Hence, the floor of the pit where recent loading has ben done, runs approximately level and within 3 or 4 ft. of the ground water line.

The Contractors and Engineers.—In January of 1923, a contract was let to the W. J. Zitterell Co. of Webster City, Ia., for the construction complete of a hydraulic type of plant.

The entire work was executed under the jurisdiction of F. L. Thompson, chief engineer of the Illinois Central System, and was under the immediate direction of Frank R. Judd, engineer of the buildings, assisted by C. I. Anderson, assistant engineer. Engineering field work for the railroad company was in charge of L. S. Marriott, assistant engineer.

The W. J. Zitterell Co. entered into a sub-contract with W. H. K. Bennett of Chicago, for the furnishing of all plant machinery, the furnishing and installing of all electrical equipment, the construction complete of the barge with its dredge pump and other equipment, and the pipe line connecting the barge to the plant. Mr. Bennett also furnished the general design of the plant. The balance of the work, including the erection of the plant machinery was handled by the W. J. Zitterell Co. with the exception of the track work and electric lighting work which was done by the railroad company. All executive work of the W. J. Zitterell Co. was handled by Mr. G. C. Mills, vice president. The engineering work was handled for the contractor in both office and field by W. A. Gelbach, supervising engineer, who was in direct supervision of the job.

Orders were placed for material and work on plans was started at once after the awarding of the contract. Field work was delayed until April 2nd by adverse weather but it was pushed vigorously despite continued bad weather from that time, as the railroad officials were particularly anxious to get the plant into operation.

The Dredging Outfit.—The unit on which the production of the plant depends is a barge 26 ft. by 60 ft. with its equipment. The principal item of equipment on the barge is a 12 in. centrifugal gravel pump directly connected to a 400 hp. 2,300 volt motor. The intake is through a Swintek traveling suction screen nozzle, 45 ft. long, on which a chain with manganese steel fingers performs the double duty of loosening the bod of gravel and excluding boulders above 8 in. in diameter from the intake.

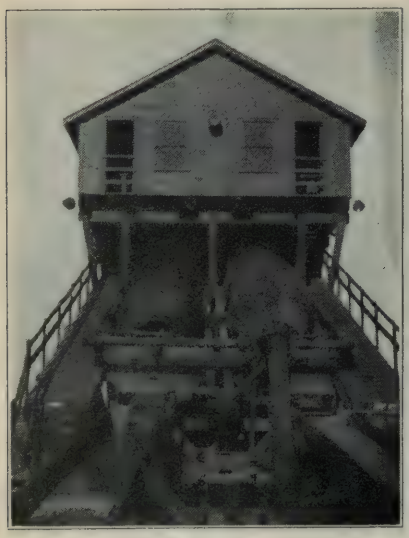
The barge is also provided with a hoist with four drums. Two of these drums are for use in moving the barge by means of cables anchored on the shore. The third is for raising the suction nozzle. The fourth is for operating a spu don the rear of the barge, the purpose of which is to serve as an anchor to steady the barge while it is working or swinging. A 2 in. centrifugal pump with direct connected 10 Hp. motor is provided for priming the gravel pump and also for providing water seal for same while running.

Trackage Layout at Forreston Gravel Pit of Illinois Central Railroad.

The barge was launched in a pond of water where the gravel had formerly been dug out below the water level. Immediately after launching, the barge was afloat in 2½ ft. to 3 ft. of water. Due to a very dry season, the water subsided nearly 1½ ft. during the two months following, and by the time the heavy barge equipment was in place and ready for operation, the bottom of the barge

was resting firmly on the mud in the bottom of the pond.

The first pumping was done on June 28th. At this time, the water and gravel were delivered through two lengths of pipe to the bank in the rear of the barge, the water returning while the cutter ground its way deeply into the bottom of the pond. On June 30th, the pipe line was connected to the plant and the first material was delivered to the bins. The first car of ballast was loaded on the evening of July 3rd. As the pumping continued, the barge was moved ahead from day to day, and



The Screens.

was finally afloat in water 25 ft. to 30 ft. deep.

The Pipe Line. — The material passes from the barge to the plant through a 12 in. iron pipe line. This pipe line is carried on pontoons to the shore, thence on stationary cribbing or on the ground to the plant. Provision is made for movement of the barge and pontoons in the water by means of rubber sleeve connections placed occasionally in the pipe line from the barge to the shore.

The 12 in. pipe line discharges its load of water, sand and gravel into a steel trough, which is installed at an incline, and at the bottom of the trough a perforated plate with ⅜ in. slots, is located. This perforated screen serves the purpose of removing the fine sand and bulk of the water. This dewatering and removal of excess sand is necessary for the proper working of the revolving boulder screen.

The Screens and Elevators.—The boulder screen is equipped with screen plate having 2½ in. diameter perforations. The boulders retained by this screen are fed into an elevator which discharges into an elevated bin of about one-car capacity. The bin discharges directly into a No. 6 crusher, which in turn, discharges into the flume under the boulder screen and there the crushed material, together with the water, sand and all material from the boulder screen, passes on by gravity to a large concrete dewatering tank having twin compartments. The water overflowing from this tank returns to the pond where the barge is operating.

Two dredging elevators, one operating in each compartment of the dewatering tank, elevate the sand and gravel to the top of the machinery house or head house, the floor of which is 62 ft. above the tracks. The elevators discharge into steel chutes, which deliver the sand and gravel into the revolving screens.

Two lines of screens with three screens in each line are used. The screens are 36 in. by 54 in. by 96 in. and have perforations of 1¼ in., ¾ in. and 5/16 in. respectively.

The water and sand from the finest screens pass on to the sand launders where it is either turned with the mixed stone to produce ballast or separated as desired for torpedo sand, engine sand, etc.

The Storage Tanks.—Five tanks or storage bins have been provided. These bins present a new departure in sand and gravel plant construction. They are of reinforced concrete 21 ft. inside diameter, and 9 in. walls. The reinforcing consists of 12 vertical, ½ in. diameter round bars in each bin, and horizontal circular bars ranging from ¾ in. round bars, 4 in. centers at bottom of the 40 ft. bins to ½ in. round bars 9 in. centers at top of bins. They were built with continuous pouring, using sliding forms in accordance with the established practice in grain elevator construction. Timber and sometimes steel plate, are the usual materials used for the bins of sand and gravel plants, and hence these concrete bins present an unusual appearance.

Three of these bins are 30 ft. high and two are 40 ft. high. Chutes from the screens are so arranged that the three sizes of stone may be run separately into the first three bins, or by use of butterfly gates, two or three of these sizes may be mixed in any one of the first three bins.

The Settling Tanks.—Six sand settling tanks or launders, tripping by gravity are provided. Two of these are placed over the third or center bin, and are intended to produce sand without separations into sizes, which is turned into the third bin together with all three sizes of stone for ballast. The third bin, therefore, is the bin in which all ballast is made, it not being possible to mix sand with stone in any other bin.

Side View of Gravel Plant, Showing Tanks and Screens.

Two sand launders each are placed over the fourth and fifth bins. When ballast is being produced, all sand is run into the launders over the third bin. When separated sand is desired, the gates to these launders are closed and the sand is washed over stationary screens over the launders supplying the fourth bin. The balance of the material then passes into the launders over the fifth or last bin. Fine sand is therefore, obtained in the fourth bin and coarse sand in the fifth bin.

Material which is pumped to the plant usually arrives in a well washed condition. The dredging elevators carry up quite a quantiy of water, which is sometimes sufficient for washing the material through the screens and sand launders. However, when the deposit of gravel is running a large percent of fine material, additional water is required in the screens and in the spouts leading to the sand launders. This water is obtained from launders. This waste water is obtained from a well 10 ft. square and about 33 ft. deep. A centrifugal water pump direct connected to a 100 hp. 440 volt motor is located in this well, about 11 ft. below the top of the ground and 5 ft. above the water level.

The Trackage.—The trackage of the plant consists of a yard for empty cars of about 60-car capacity, a yard for loaded cars of about 70-car capacity, a loading track each side of the plant, and a passing track removing loaded cars. The empty cars are started in the yard on a 1 per cent grade and dropped on this grade to the plant where they are stopped by a 0.5 per cent grade, loaded, started again by means of a car puller, and dropped down another 1 per cent grade to the load yard. The loads are taken out by a locomotive over a direct road past the plant and empty car yard to the main line.

A combination office, storehouse and shop building was provided, 18 ft. by 64 ft., giving an office space approximately 12 ft. by 17 ft., a storeroom approximately 17 ft. by 28 ft. and a shop approximately 17 ft. by 24 ft.

The Power Equipment.—Electric power is obtained from a power line which parallels the Illinois Central tracks at this point. A 2,300-volt line from the power company's sub-station delivers power to the plant. This line is carried to the barge by means

of a specially insulated flexible cable carried on tripods on the shore and supported on the pipeline pontoons over the water. A reel house is provided near the plant, housing a triple reel on which the three phases may be rolled up during the winter months while the plant is idle, or on which extra length of cable may be wound.

A transformer on the barge provided 440-volt current for all motors except the main pump motor, and a transformer located near the plant provides 440 volt current for all motors used there.

All motors on the barge provided 440-volt current for all motors except the main pump motor, and a transformer located near the plant provides 440-volt current for all motors used there.

All motors are provided with the latest approved type of controllers.

The motors are used on the plant as follows:

On barge—
1 400 hp. 2,300 volt on gravel pump.
1 15 hp. 440 volt on hoist.
1 15 hp. 440 volt on nozzle cutter chains.
1 10 hp. 440 volt on priming pump.
At plant—
1 100 hp. 440 volt well pump.
1 50 hp. 440 volt crusher.
2 40 hp. 440 volt elevators.
2 hp. 440 volt screens.
1 15 hp. 440 volt boulder screen and elevator.
1 7½ hp. 440 volt car puller.

The electric lighting work which was done by the railroad company's forces is very complete and effective. Six large flood lights located on the machinery house on the top of the plant light up the vicinity of the plant and both the empty car and loaded car yards. On the barge three flood lights give the operator very advantageous working conditions and one of these lights may be adjusted to light up the pipe lines.

Operating Force.—The operation of the plant was taken over by the railroad company on July 1st, and is being operated by the Maintenance of Way Department, who have employed Mr. John Markham as superintendent. Work on a night shift was begun the night of July 31st.

End View of Forreston Gravel Plant of Illinois Central Railroad.

The force required to run the plant based on running a day shift only, is as follows:

1 superintendent—directing.
1 assistant superintendent—office work, billing cars.
1 barge man—pumping.
1 barge helper.
1 screen tender.
1 man on crusher, boulder screen, etc.
2 men loading cars.

4 men running cars (empties and loads).

1 man on car puller.

The rated output of the plant when in full operation is about 50 cars per day of 10 hours. This output, however, undoubtedly, will not be attained during the present season. The barge is still operating in too small a lake to work efficiently, it being necessary to shut down the plant frequently to add new length of pipe to discharge line. Production is further very much reduced by a very hard stratum about 4 ft. in thickness which lies about 10 ft. below the surface of the water. The necessity of training an entire new force of men for both day and night shift has also had its effect. In addition to these factors there is the necessity of at least some experimentation in the operation of every new plant.

The Old Time Roadmaster

Extract from Address Presented Sept. 19 at Annual Convention of Roadmasters and Maintenance of Way Association

By COL. F. G. JONAH,

Assistant to President and Chief Engineer, St. Louis & San Francisco Railroad.

My association with roadmasters began with my entrance in the engineering department, and has continued ever since, covring a peeriod of 40 years.

As I look back and call to memory some of the stalwart roadmasters with whom I became acquainted in my early days of railroading I have a feeling of admiration for their ability and achievements, for it seems to me that they did wonders with the material at hand.

If you contrast the conditions under which they worked with those of the present, you cannot fail to be impressed with the fact that some improvement has been made, but I think you will also agree that none of us could do any better than they did, and possibly not so well.

The roadmaster of 40 and 50 years ago had to work with tools that were comparatively crude. There were practically no power driven machines in those days and, in fact, very little machinery of any kind. There were no modern ditching machines, air dump cars, or gasoline motor cars, and the day's performance was measured by hand labor almost entirely.

The roadmasters of those days had a light rail, scant ballast, if any, no tie plates, rail anchors, spring rail frogs, split switches, or the great multitude of track accessories that have been developed in the past few years. It is true that the motive power of those days were much lighter than it is today, but we have increased the weight of rail and the depth of ballast, and have widened our roadbeds to take care of those added loads.

The roadmaster of that early day had to maintain the track very generally without ballast, and in putting up earth or dirt track he was an artist that has no equal at the present time. He was also the main reliance when any trouble occurred on the road, for he was, in fact, the wrecking boss, and was the first man called upon when any unusual events occurred anywhere on the line.

The old time roadmaster was a good construction man. He was developed at a time when the American railroads were being built, and he was at the front. Many of the roadmasters of those days were men who had made records as construction foremen, and where they had a chance to display originality, initiative, and skill.

Today your work is largely maintenance, where your work is more uniformly standardized. I suppose that with our changing conditions this is inevitable and as it should be; but while I approve of the standardization of methods, I do not believe in trying to standardize railway men.

In former days the roadmaster was the company's representative to a much greater extent than at present. He did a great many things that are now done by other departments. He frequently acted for the legal department and settled many stock claims, claims for crops burnt, and those resulting from overflows, etc. He acted frequently for the purchasing department and contracted for ties, piling, fence posts, bridge timbers, ballast, etc. I believe that they could do more of this kind of work today. One of the tendencies in railroading today is to do too many things with special representatives from the general offices.

Finance and Engineering

Some of the Problems of the Financier Outlined in Paper Presented Before Western Society of Engineers

By H. M. BYLLESBY,
President H. M. Byllesby & Co.

The engineering profession, in its broadest sense, and in its best development and manifestation, is a profession that requires and cultivates that faculty which is known now-a-days as the constructive side, years ago was the enterprising side, the prophetic side. The engineer, if he rises from his rut, at once dreams dreams, he sees projects, he analyzes them, and, in a few cases, those projects are supported by the neccessary capital and are put into commission.

Now this vision, this enterprise, this constructive side, is very very necessary. At the same time, leaving engineering aside, and stepping on the other side, the financial, I want to urge upon you in dreaming your dreams and in having your visions, which you must have, always to bring in, as far as it is possible, so long as you avoid going to the pessimistic side, the question, or the element, of caution and conservatism.

What Financing Is.—Financing is simply the providing of the labor, the materials, the designing, directing and executive ability necessary to design, to build, to complete and to put in operation any engineering work. The engineer may dream himself into starvation over plans and projects which may be of the most far-reaching and profitable, and withal beneficent nature, but unless he is able to interest and to command the services of the financier he is apt to starve himself and his family and dependents in a more or less exalted condition of mental and ethical uplift, and the engineering work would not be produced.

Speaking to you, who are so largely of the professional engineering type, who belong to a profession which in point of dignity and benefit to humanity is second to none in the entire world, it would be idle to call your attention to the enormous difficulties which are encountered, the infinite resource which is required, the moral attributes which are essential through the successful practice of your profession. This all of us who are engineers appreciate.

It is my deliberate judgment, from a somewhat long and busy career, which has been prolific in opportunities for observation, that there is no class of men, as a class, who in fact have more highly developed that fine moral attribute of straight and conscientious thinking than the engineer. The engineer perforce is compelled to follow through it, no matter where it leads or what conclusions it may bring.

Engineer and Financier Closely Inter-related.—I would like to call your attention—again having as our main motive the thesis that the engineer and the financier are as closely interrelated and inter-dependent as any of the branches of human activity—to some of the problems of the financier, some of the difficulties he encounters, to touch only briefly on the staggering losses which he frequently has to stand in carrying out his part of the partnership, that is the finding of labor and material—that is money—for the carrying out of the engineering works designed and constructed by the various branches of the engineering profession.

I hold no brief for the financier. His trade or profession is not in the public estimation on as high a standing or actuated by as high ideals as the engineer and other kindred professions. He has a different field in which to work. As a rule only a part—a small part frequently—of the total amount of money provided for a given engineering work at his hands is supplied by himself; in fact the professional finder of money for engineering projects—even the largest banking houses—find it necessary, in order to enable them to continue to finance projects, to distribute among their clients, the great army of investors, that is people of thrift, the stocks or bonds, which in the first instance they purchase, to provide the capital which it is expected will finish the work.

How an Enterprise Is Financed.—As a rule the financial house or group of financial houses who underwrite—which means that they obligate themselves to pay, all at once or as the

work progresses, a given definite amount of money contracted for—as an initial step, make a loan from a bank or banks on the stocks or bonds purchased, supplying a margin of 20 per cent out of their own capital the difference between the one million dollars, for instance, which they have contracted to turn over to the corporation which is building the given engineering work, and the amount of money which they are able to borrow from their banks, so that if they turn over initially $1,000,000 to the corporation it means generally that they have borrowed from banks $800,000, and supplied, pending the distribution of the securities, $200,000 out of their own working resources.

The next step, of course, is for the financial agency, generally termed the "banker" to proceed to dispose of these securities—which as a matter of fact he has purchased, and for which he has paid $1,000,000, and upon which he has borrowed $800,000—as quickly as possible to his own clients.

If nothing strongly adverse in public opinion surrounds the enterprise, that is to say if it looks like a reasonable enterprise and if no disaster overtakes the project in its early stages, the banker will have disposed of the securities he has purchased, we will assume, within a reasonable period, and before the maturity of his loan at his bank, so that he has paid his loan to his bank, which we have assumed at $800,000, he has restored to his own working resources the $200,000 which he used as a margin, and he has in cash the difference between the gross profit he has made on the sale of the securities and the cost of selling them, including the proper share of his general overhead expense.

Now, if everything goes well the project is finished without any overrun in its estimated cost, it starts off as a successful venture, the banker has not only secured for himself a perfectly fair, we will assume satisfactory, profit from handling this transaction, but he has gone further and he has made his clients, to whom he retailed these securities, feel well towards his house, and in the highly desirable event, which I regret to say is not always realized, that the securities he has sold go to a premium he has additionally fortified his position.

Financing of Next Enterprise.—In this ideal transaction, the project being finished without any burdensome floating debt and starting off at once on a phenomenally profitable basis, and the securities sold having gone to a substantial premium, the banker is then in a position in taking on his next enterprise to feel reasonably certain, barring the advent of dull times or financial panic, of promptly placing the securities of the new enterprise with, by way of illustration, the identical clients to whom he sold the securities of the first enterprise.

These clients may be in one or two classes—generally will be,—either clients who again have money to invest, who do not desire to dispose of the securities they purchased in the first project, and which have done admirably, and in this case these clients would probably purchase their share of the securities of the second proposition; or they may be in the class of people who possibly are not of large means, or, as is frequently the case, are of a speculative turn of mind, and possibly themselves carrying loans on the securities which they have purchased and paid for in the first project. In this case the banker has the opportunity which above all others he desires. He can say to Investor "A," who is in the second class named, "You paid $10,000 for the securities of Project No. 1. Those securities which you purchased for $10,000, and upon which you have received a substantial income return, are now at a premium, so that I can pay you $12,000 for the securities you purchased in the first undertaking, and I have now another undertaking, which I believe will be just as satisfactory, and you can re-invest that $12,000 in the securities of the new undertaking, or you can invest $10,000 in the new undertaking, being the same amount which you invested in the first, and receive $2,000 cash profit."

It is not necessary to go into further detail. The banker who is in the position described in a somewhat sketchy fashion has no difficulty whatsoever in immediately placing the second undertaking, and at least for the present having gained for himself the proper profit from placing the first undertaking and the proper profit from placing the second undertaking.

What Happens When the Undertaking Turns Out Badly.—However, there is another, and very frequent, side to the picture. Briefly, the first undertaking turns out badly. Due to

an under-estimate on the part of our profession who designed and planned the enterprise there may be, and alas very, very frequently is, an excessive over-run in the cost beyond the amount provided for when the finaancial structure of the undertaking was decided upon. Then the banker, no less than the corporation, has the heart-rending task of endeavoring to place some extension securities, to finish the project, with the public, or with those who put their money in the project at the start, or, as is very frequently the case, himself buying these securities and carrying them at the bank, or loaning the enterprise money with which to finish.

This situation of course promptly becomes known to his clients, who provided the money for the undertaking. The inexperienced ones as a rule are full of wrath; they mutter a good deal at that time about criminal carelessness, inexcusable negligence and criminal optimism; some of them decide they will dump their securities on the market, take their loss and proceed on their way as sadder but wiser individuals; others decide they will hold on to what they have, but that it is not convenient for them to take any further interest.

The attitude of both of these groups is extremely embarrassing to the banker. Temporarily he has lost prestige; he has lost the confidence of his clients; he is more or less debarred from putting out anything new until Project No. 1 has either more or less painfully pulled itself out and justified or paid off its over-run in cost; or in event of permanent failure, or that thing which is almost worse than failure, dragging out an existence, he has to go through the wearying round of explaining to his clients that he exercised every possible prudence, that there was no dishonesty, that there was no negligence, but that simply fortuitous circumstances, which could not have been anticipated developed and crushed the chicken in the egg. If Project No. 1 turns out disastrously or disappointingly, it is a very severe set-back to the banker, and unless he has had a long experience of great success and his established clients have through a term of years made distinct profit by dealing with him and the emissions of his house, he is put in a position where he is liable to have loaded himself up with unsalable securities, which either he has been forced to take off the market with his own money and with the aid of bank loans in order to prevent a demoralization of the market, or again through his own resources and his banks he has had to borrow money for the corporation. Not only does this take the heart out of the banker, but it hamstrings his ability to go further.

Fair Dealing Necessary.—This illustration of course is simple and plain. It is probably known to all of you, but I cannot emphasize to you too strongly the necessity of mutual fair-dealing. The banker himself, if he undertakes the financing of a corporation, must do it on a fair and reasonable basis. He should only undertake the financing of such a project when he himself, as the result of reports by engineers and commercial men, is able to determine to his own satisfaction that the project will be a success, and further that its financial structure, that is to say its capitalization, shall be such that, first, it will have an opportunity, due to its structure, to keep its securities in a good market position, and, secondly, and equally important, that its financial structure shall be such that if, due to very frequent perfectly honest over-run in cost, it is necessary to put out additional securities they can be issued on all fours with the securities first put out, to enable the undertaking to be finished without undergoing some cut-throat financial temporary expedient, and that, providing the project is one which has reason to anticipate a further or continued development, securities can be issued to provide the additional capital for the further development of the enterprise on a fair and reasonable basis.

Determining the Value of a Security.—Another point, which I think is always of importance to the engineer, as well as to all the thrifty branches of our present business and industrial world, is that of determining the value of a given security, whether in the initial promotion or organization, or at some subsequent date. The point that must be continually kept in mind is the effect upon the salable value of any given security which results from that security having a ready and immediate, what is known as a free and broad market, as against the security which it may take days, weeks or months to sell because it has no such market. By illustration, any man in middle age is liable to have in his in-

vestments bonds or stocks which are absolutely sound, the emissions of perfectly sound and well-managed enterprises, but which due to the obscurity of the enterprise or project, or the relative smallness of it, are very difficult to sell, and following this position are distinctly difficult to use as collateral at the bank for the purpose of making temporary collateral loans. Securities of this kind will always have a lower price and will always be more difficult to sell than securities with a free and ready market. Likewise, in order to make them attractive, such securities must give a far more substantial return than the security of a free market.

Again by illustration, consider the U. S. Government Bonds, all the issues of which are at any moment of the day and any day of the year immediately convertible into cash. They are available as the best type of collateral at any bank, whether a country, or a city bank, because they have this broad and free market, and in normal times have no very wide fluctuation. Of a similar class, although it has broad fluctuations, but similar in point of its immediate convertibility into cash, is the common stock of the United States Steel Corporation, where to a relatively unlimited amount this stock can be sold to a broker by telegraph on the New York Stock Exchange at a moment's notice. Again, in the same class, are the seasoned railway and corporation bonds listed on the New York Stock Exchange.

Frequently the professional man or the builder, who is not familiar with practical modern commerce and the affairs in the financial market feels that because some thoroughly seasoned bond or other security has an immediate market at par, where it yields, in the case of a bond five per cent in these times, or in the case of a stock from six to eight per cent, that the unknown security of an obscure project, where there is no general market for the purchase and sale of such securities, should yield to the investor no greater return than the aforesaid bonds or stocks with absolutely free and unlimited market. Frequently in my own experience I have found people who are negotiating for the building of a project or its extension taking as their basis of the return to the investment the published call money rates in New York City. If they are securities which have as free a market as a call loan has in New York, and have back of them the same immediately available cash features as a New York call loan has they would, of course, be able to place them at the same rate, or substantially so, as call money in New York.

I think the engineer may at times have somewhat hard feelings towards the financial end of the game. I think he should ponder on some of the difficulties of the financial people, that is of the finders of money, their profession is the finding of money, just as the business of the engineer or contractor is the designing and the building of engineering work. The financier operate at least 80 per cent with the money of his clients. Every now and again there are issues of many millions of dollars purchased by a banking house or a group of such institutions. For the moment the purchasing group have, by putting in their own resources to such an extent as was necessary for margins, borrowed from banks the balance of the many millions which they have put to the corporation, but if they were unable to retail the securities so purchased among their clients they would simply be out of business, they would have done one piece of business and stopped forever, just like certain of the insects who spend years in incubation have a life of dazzling brilliancy and luxury for a period of 24 hours to a week, to be followed by complete oblivion.

Governmental Interference with Conduct of Corporations.—Another feature which is making the financing of projects increasingly difficult is the extent to which various state governments are interfering with the conduct of corporations and the extent to which in other cases the federal government is increasing the weight of its paternal hand upon such enterprises. Many sadly foolish things, many disastrous things, have resulted from engineers and their works and from bankers, their methods and their works. Wealth, whether large or small, has as a prevailing characteristic a certain aggressive selfishness. This has always been so, and will continue at least until the youngest in this room has been gathered at the close of a long, and we hope successful, career to rest with his forebears. A certain amount of regulation is necessary, but the regulation which goes too far, which savors of the religious presecu-

tions of some hundred years ago, is restrictive to real progress. While it may hold back a relatively few men or corporations immorally disposed, it prevents useful and profitable employment of many others whose work would be beyond criticism.

The engineer is a man of influence in his own circle, in his own life and surroundings. Aside from the mere pleasure of practicing one's profession, the well-being of the engineer, the opportunity to provide a competence for himself and his dependents —broadly, the opportunity to be really normal and happy in life—depends upon the continuous development of engineering works; and unless this country goes backward to municipal, state and Federal ownership, with all its attendant dry-rot and submergence of the individual and the throttling of his very best moral, mental and spiritual side, then the only way that the engineer can find a continuous field for the application of his talents and genius in the construction of engineering works is by seeing that the laws, whether municipal, state or federal, do not so oppress the conduct of so-called privately owned engineering works as to make it literally impossible or extremely burdensome to provide the means for their development.

Portland Cement Production in September

According to figures of the U. S. Geological Survey just released production of portland cement in September eclipsed all previous records for any single month. For the first time the 13,000,000 mark was reached, the exact quantity produced being 13,109,000 bbl. Production for the nine months ending September 30 was slightly over 101,000,000 bbl. or more than was produced in any full year prior to 1922. Last year's nine months record output was exceeded by about 24 per cent. Shipments from the mills during September, although less than in August, were greatly in excess of any corresponding month in past years and were about 10 per cent over September 1922. For the first nine months of this year shipments were substantially in excess of 104,000,000 bbl. or 18 per cent greater than during the corresponding months of last year.

Labor Saving Devices in Track Work

Committee Report Presented Sept. 20 at Annual Convention of Roadmasters and Maintenance of Way Association

Cranes, Air Hoists, Buckets, Etc.—Let us first consider the uses to which the ordinary steam crane can be put. It will reduce labor, hazard and time, and will handle frogs, switches, guard rails and heavy switch timbers, will load and unload rails and should be more generally used for lifting in new rail, and lifting out the old, when rails are being renewed. We have had several elaborate reports on the practicability of laying rail in this manner, which makes any further description of this work unnecessary at this time. Among the newer devices that are rapidly being applied to cranes are magnets by which scrap, tie plates, angle bars, etc., can be picked up quickly and at minimum cost. Where the cranes are self-propelled, they eliminate the cost of any engine, except to get them on the scene of operations, reducing the cost accordingly.

Clam shell buckets are now used to load cinders, clean ballast, and do various other kinds of work.

Air hoists of many different designs with power supplied from the train line or from a compressor run by a gasoline engine are used for rail laying, and for loading and unloading when this work can be done by hand-driven machines.

Ditching Machinery—Would anyone care to go back to the days when we had to organize a gang of 35 men with rubber boots, picks, shovels, an engine and a train crew with flat cars to do ditching, when such equipment as the roadbed spreader and ditching machines are available? The new feature of the spreader is a ditching wing that can be set at any angle, by means of which the material is dragged out of cuts, the slopes and ditches shaped and drainage provided with the aid of only one or two laborers. For the same purpose the hoisting ditcher is adapted to slope a bank at any angle, cut to any depth and load the material excavated on cars, backing along the top of the cars as they are loaded. Comparative figures between ditching with the roadbed spreader and the hoisting ditcher are not available, but it is

understood that, under certain conditions, the roadbed spreader is the most economical. This device, of course, has many other uses, as does the hoisting ditcher.

Ballast Cleaning Equipment. — Where ballast becomes so foul from cinders, sparks and dust that it becomes necessary to move and clean it, the only method that has been developed so far has been the use of the clam shell with large screens placed on a ballast car, with a hoist to pick up the ballast and drop it on the screen, the dirt falling in the car and the clean ballast going back between the tracks. It is, of course, understood that the clam shell can only take the ballast from between tracks or not very satifactorily from the shoulder outside of the ties. If the ballast from between the rails must be cleaned, it must be shoveled out to either the side or center between tracks. Nevertheless this is a decided labor saving method of doing this work.

There is also the power-operated ballast screen which consists of a belt conveyor and revolving screen driven by a gasoline engine, which also provides power to move the machine along the track as the work progresses or from one job to another and can develop a speed of 20 miles per hour. This machine is so constructed that it can be removed from the track with about the same effort as a tie tamping machine. Stone to be cleaned must first be shoveled out from between the ties, and then shoveled into a long trough through which a belt is operated, conveying the stone to the revolving screen. The force to operate this device in an efficient manner depends on local conditions, the following being found to be the most efficient, with which about 96 ft. of track can be cleaned per hour.

1 foreman.

10 men shoveling out in advance of the machine.

7 men placing the stone in the machine, three on the outside shoulder and four in the space between the tracks.

1 man disposing of the dirt at the seven-foot line.

1 assistant foreman in charge of the machine and operating the stone cutter.

1 machine operator.

1 flagman.

If the delay from traffic does not exceed 25 per cent of the actual time worked, the cost is about 15ct. per lineal foot of track cleaned or 45ct. per cubic yard of stone ballast.

We read also of a suction machine having been constructed to remove this undesirable matter from stone ballast, but we have not sufficient information to describe its operation.

Weed Removal Device. — Where weeds growing in the stone ballast constitute the objectionable matter to be removed, a device is now made to be applied to the side of a car with machinery to raise and lower it, similar to a roadbed spreader. An A-frame is made into which steel teeth are set which can be adjusted to the contour of the center space between tracks or the shoulder outside. When this device is drawn at a speed of from 6 to 8 miles per hour, it roots up and renovates the ballast, letting any small particles go down in the ballast and making the surface look clean and fresh as new stone. This machine, run frequently, saves much labor over hard weeding in stone ballast, but of course does not effectually clean it. It is suggested that a machine of entirely different type could be designed for the purpose of cleaning the stone ballast that would scoop up the stone into a conveyor, screen it and return the clean stone to the roadbed and at the same time load the dirt into a car.

Tie Tamping Machine, Track Drills, Etc.—For tamping ballast under the ties we have the pneumatic tie tamper which, is an acknowledged help in this class of work.

Track drills for turning nuts on track bolts, equipment to bore ties and timber and cutting and chipping tools are now available with these machines and are comparatively inexpensive, considering the savings that can be effected by their use. A mile of badly corroded nuts on track bolts can be cut off in four hours with two pneumatic rivet cutters, which work would require at least 12 men with chisels and sledges.

The latest feature of track work to receive attention is the lining of track. At least two devices permit us to throw track with less than one-half the men otherwise required. These devices will require some improvement yet to guard against lifting the track while lining it for otherwise the the expensive operation of surfacing the track will be thrown away.

Treatment and Care of Railroad Ties

Practice of Atchison, Topeka & Santa Fe Ry. Described in Paper Presented Sept. 18 Before Roadmasters and Maintenance of Way Association

By S. D. COOPER,
Assistant Manager Treating Plants, Santa Fe System.

The Sante Fe commenced to treat ties in 1885 at Las Vegas, New Mex. In 1897 a second plant was started at Somerville, Tex., and in 1898 a third plant was started at Bellemont, Ariz. In August, 1906, the plant at Bellemont, was burned down and in January, 1908, the plant at Las Vegas was also burned. In 1908 a new treating plant was erected and put in operation at Albuquerque, New Mex., consolidating the two plants at Bellemont, Ariz., and Las Vegas, New Mex. We are at present erecting another new plant at National City, Calif., which is close to San Siego. This should be in operation by January, 1924, and will give us three plants owned and operated by the Santa Fe.

The Adzing and Boring Machine.

Early Tie Treatment.—From 1885 to 1901 we treated our ties by the Wellhouse process which is a combination of chloride of zinc, glue and tannin; from 1902 to 1905 by the Burnettizing process which is a treatment with chloride of zinc only. In 1906 we built a new plant at Somerville, Tex., to take the place of the old one at that point and commenced to treat all our ties with creosote by the Rueping process. This year we have commenced to treat all our ties with mixture treatment. In the territory supplied by our Somerville plant with 70 per cent creosote and 30 per cent petroleum oil and in the territory supplied by our Albuquerque plant, which is a much drier climate, with 50 per cent creosote and 50 per cent petroleum oil, leaving in about 7½ lb. of mixture to the cubic foot.

From extensive experiments carried on since 1909 we are satisfied that the addition of the petroleum oil which has an asphaltic base adds considerably to the mechanical life of our ties.

Classification of Ties.—All of our cross ties, lumber and piling are purchased by our general purchasing

agent who has an efficient staff of inspectors and they inspect all of this material at the point of origin. They make very careful inspection and we have no reason to complain about the quality of the material. Our classification is as follows:

First class of No. 1 ties are—6 in. x 8 in. x 8 ft., 7 in. x 8 in. x 8 ft., 7 in. x 9 in., x 8 ft., hewn or sawn, all woods.

Second class or No. 2 ties are—Any sound tie of cross section under 6 in. x 8 in. with 6 in. x 7 in. minimum, hewn or sawn, all woods; also No. 1 sizes rejected from first-class account of some slight defect.

When the ties are received at the treating plant they are stacked for seasoning, as it is the practice on the Santa Fe to treat nothing but air seasoned material.

Adzing and Boring Ties.—When ready for treatment they are loaded up and put through an adzing and boring machine.

This machine adzes a place for the tie plate, bores the holes for the spikes and also cut off about ¼ in. from each end of the tie. This machine then stamps on one end of the tie the kind of wood and weight of rail for which the tie is bored, and on the other end of the tie the kind of treatment and the year treated.

This cutting off the end of the tie really gives us another inspection as we sometimes find indications of rot after the cut which otherwise it would be impossible to detect and these ties of course are culled. The ties are loaded from the machine onto tram cars and pulled direct to the treating cylinders.

After the ties have been treated they are again stacked for seasoning before being shipped out, and we place much importance on this feature, as we know that we get better life results from this practice. This seasoning period lasts about three months.

Load of Ties Ready for Treating Cylinders.

Distribution of Ties.—When the ties are ready for shipment to be inserted, they are ordered and distributed. This provides for certain species of woods to be used in definite localities for each class of track; and in every case, provides for hardwood ties being used on all curves of 2° and upwards, wherever located; softwood ties, such

as native pine, Oregon fir, New Mexico pine, and redwood, being used on tangents in the various districts to which they have been assigned.

We are of the opinion that the proper distribution of ties is a very considerable factor in their life.

Marking Ties in Track.—When the ties are inserted in the track the instructions are that each tie must have a tie plate, and these instructions are very carefully followed. The size of the plate is 7½ in. x 9 in. and practically covers the face of the tie.

On every tie inserted a dating nail is placed; a round head nail for a treated tie and a square head nail for an untreated tie. This nail bears the year of insertion and is placed on the end of tie about half way between the end of the tie and the rail base, and is a ready means of identification.

In addition to providing a ready means of identification as to the year of insertion, I think it is of great value in other ways. A section foreman will invariably give a tie of comparatively short life a much more close inspection than if there was no nail showing it's life, before taking it out of track. I have seen it demonstrated over and over again.

Experimental Sections.—Commencing in 1904 we started to keep a record of all ties inserted in the track on all parts of the system and continued this until 1910 when we found that this was impracticable and did not work out satisfactorily, so in 1910 an experimental section was established on each superintendent's division, these sections being selected by the general managers, general superintendents and superintendents of each division, the section selected being an average section of the conditions on that territory and each section being a regular section foremen's section.

A careful record was made of each tie as it appears in the track, and these sections are carefully checked each year by representatives from the manager of treating plants' office. A report is sent out each year for each section to the vice-president in charge of operation, general managers, assistant general managers, superintendents, division engineers, roadmasters, section foremen, and also to the chief engineer of the system, and assistant chief engineer system, to whom the manager of treating plants reports.

In addition to these annual inspections visits are made periodically to each experimental section when the ties taken out of the track are inspected before being destroyed.

In addition to this, we have several sections of track where ties have been laid out of face where we keep a close record of the life of the ties.

By these means we are able to keep a very close and accurate record of the life we are getting from our ties. A record of the service of our ties inserted in regular practice of spotting in and also a record of the service given by ties inserted out of face.

In addition to the inspection of our experimental sections, we have inspectors with motor cars who inspect all ties found on the right-of-way. On these inspections, they are accompanied by the roadmaster over his territory, and a report is made daily of the ties inspected, giving the year of insertion when possible, and the cause of removal. A copy of the report covering each superintendent's division is sent to the general manager, superintendent of the division, and the chief engineer of the system.

It might be thought that on these inspections there might be some feeling on the part of the local people on being checked up so closely but the contrary is the case. I think I am safe in saying that the very large majority of our people realize that we are trying to educate our section foremen in the proper handling of our ties and I can say without fear of contradiction that we have the hearty support of superintendents, roadmasters and section foremen in our endeavor to get the longest possible service out of our ties, compatible with good track.

When these inspections were first started some years ago, we found quite a number of ties that should not have come out of the track, but now we find very few indeed on the right-of-way that should not have been removed from track; and this is entirely due to the intelligent and wholehearted support of everybody concerned.

I have in mind a recent inspection on a superintendent's division where not a single tie was found on the right-of-way that should not have been taken out of the track.

I have tried to briefly as possible

put before you Santa Fe practice. The question probably arises in your minds as to whether such an organization is profitable to the management of the railroad. I think of no better answer than the following as I think the figures speak for themselves:

In 1885 we treated 111,503 ties.

From 1885 to 1922 we treated 70,499,756 ties.

In addition to this we treated from 1896 to 1922, inclusive, 225,452,256 board feet of lumber; and from 1895 to 1922, 10,714,269 lineal feet piling.

Results of Tie Treatment.—This, I think, demonstrates beyond all question that the management is satisfied that the treatment of material is an economical proposition; and as to what the management is getting out of the treatment the following will show conclusively:

Take one section of ties laid out of face—and this I selected because it is easy of access for anyone interested who cares to go and see, and let me say here that we will be more than glad to make arrangements for any of you who would like to inspect these ties to do so.

The stretch is just out of Melvern, Kan., on our Ottawa Cut-off, main line traffic, passenger and freight; possibly the heaviest traffic we have. Between M. P. 80 and 87 plus 3155 we inserted in 1906, 24,238 hewn Texas pine ties, treated with creosote by the Rueping process.

Our annual inspection at the end of 1922 showed 833 ties removed, only 3 of them on account of rot, the balance being taken out on account of other causes; 3.44 per cent removed, and the life given by these ties up to the end of 1922 was 15.97 years. From the present appearance of these ties, I will be very much disappointed if we don't get an average life of at least 20 years, and this, as stated before, under the heaviest traffic on our road.

One more record which speaks for itself: In 1898 we used for tie renewals on the Santa Fe System—then 8,185 miles—336 ties to the mile. In 1922, with 17,104 miles, we used 158 ties to the mile—less than half of the ties per mile used in renewals in 1922 than in 1898. This, was done, under conditions no different in 1898 than in 1922 when the power is much heavier and the traffic much more dense.

I give below the number of ties used for renewals in number and per mile from 1898 to 1922 inclusive:

Statement Showing Average Ties Inserted
A., T. & S. F. Fy. System

Year	Total Miles	Total Ties Inserted Renewals	Total Ties Inserted per Mile
1898	8,185	2,751,849	336
1899	9,028	2,246,250	249
1900	8,804	1,687,537	192
1901	9,368	1,557,866	166
1902	9,557	1,955,093	205
1903	9,768	2,352,502	241
1904	10,237	2,770,306	271
1905	10,885	2,788,378	256
1906	11,637	2,291,997	197
1907	11,694	3,365,017	288
1908	12,169	3,667,181	301
1909	12,601	3,691,623	293
1910	13,379	3,758,984	281
1911	13,869	3,781,745	272
1912	14,488	3,252,061	224
1913	14,766	2,868,889	194
1914	15,293	2,753,842	180
1915	15,409	3,234,760	210
1916	16,151	3,118,941	193
1917	16,276	2,463,651	153
1918	16,554	2,456,599	151
1919	16,711	2,302,952	139
1920	16,924	2,753,673	163
1921	16,933	2,514,325	148
1922	17,104	2,693,905	158

Given good material to treat, adzing and boring same before treatment, the material properly treated, followed by intelligent and careful supervision after treatment, I think you will agree that the figures given above clearly demonstrate the economy of the preservation of ties. The records given as the result of Santa Fe practice can be duplicated by any railroad in the country.

Steel Tank Safety Refuge in Blasting

Men engaged in blasting at quarries need some safety refuge that can be readily moved from place to place as the work progresses. Without such a protection the men spend too much time in getting off to a safe distance and then coming back to work. According to Successful Methods the Louisville Cement Co. of Louisville, Ky., has happily solved the problem, and is speeding up production, by the simple expedient of providing cylindrical steel tanks. These tanks were formerly coolers in the cement mill proper. They were converted into places of safety by merely closing up one end with heavy timbers and bolting 2x4 in. timbers extending a full length on either side for the men to brace themselves against. These tanks can easily be rolled from place to place and can be stationed fairly close to the blast.

Mucking in Mines with Portable Hoists

Practice in the Lake Superior District Described in Mine and Quarry

By J. A. NOYES

The general principle of ore slushing is very old, not only in mining, but also in general contract work. The ordinary horse drawn contractor's slip scraper such as is used for general excavation work is in principle just the same as ore slushing with a single drum hoist. The contractor also has what is practically the double drum slusher in the ordinary drag line excavator and also in his back-filling machine, which he uses for dragging the loose dirt that has been excavated from a trench back into the trench again to fill it up after the pipe line has been laid.

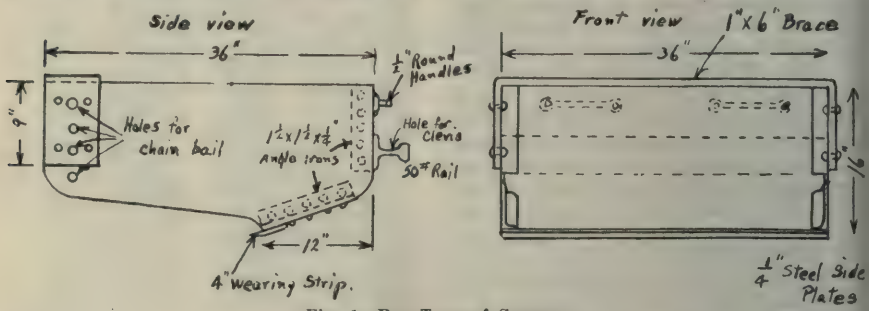


Fig. 1—Box Type of Scraper.

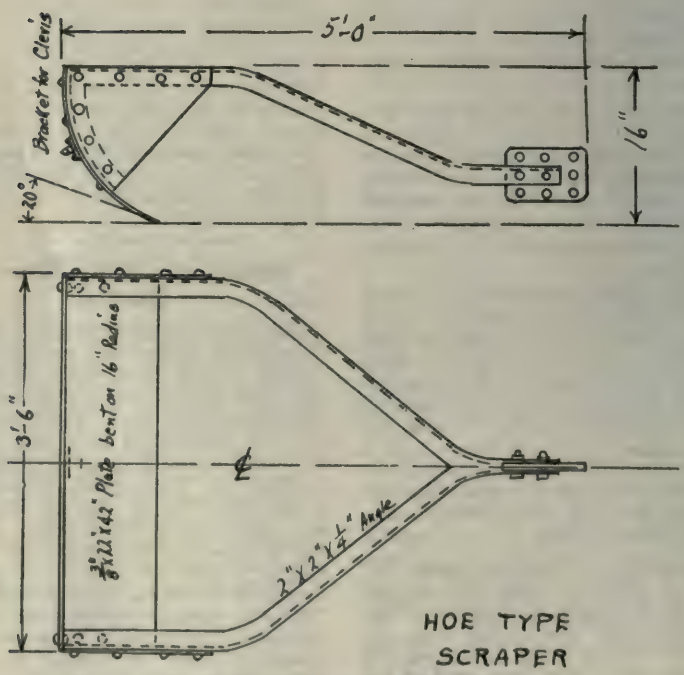


Fig. 2—Bottomless or Hoe Type Scraper.

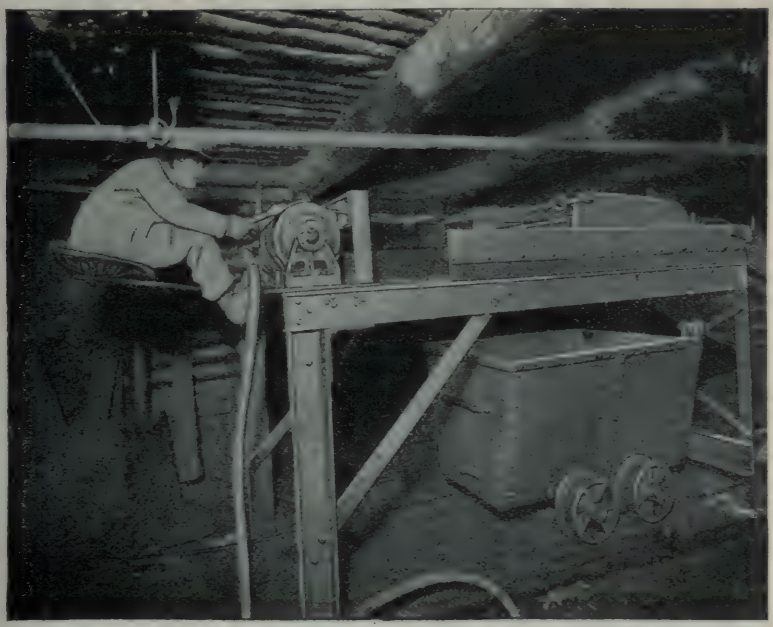
The contractor uses his scrapers for both digging loose material and for

hauling it at the same time as one operation. In the same way the practice of ore slushing takes the place of both shoveling and tramming. This eliminates the expense of laying and moving tracks.

The first slushing that was done in the mines in the Lake Superior country was done with the single drum machines, and the scraper was an ordinary contractor's slip scraper weighing approximately 50 lb. and having a capacity of a little over 3 cu. ft. The single drum hoist was set up at the top of a raise and the loaded scraper hauled in to it bringing a load of approximately 5 cu. ft. The extra 2 cu. ft. of material represented that which was piled up on and pushed ahead of the scraper. The load was dumped into the raise by hand and the miner dragged the empty scraper back to the pile of dirt where he again guided the scraper in digging it into the pile of material. A second miner operated the hoist.

Double Drum Hoist Adopted.—It was only a step from the use of the single drum hoist and hand scrapers to the use of double drum hoists and larger and heavier scrapers, that were self-digging and self-dumping. One drum hauls in the loaded scraper and the other drum pulls it back, using a tail rope running around a sheave wheel located in the breast or heading. In slushing with the double drum machines two men constitute a crew, but the actual manual labor required is very little. One man operates the hoist and his partner trims the back, picks down loose ore, moves the tail sheave and occasionally rides the scraper as it takes its load.

Types of Scrapers.—The following three sketches illustrate three different classes of scrapers. All three classes are the bottomless type, each one scraping or pushing the material and not actually carrying it as is the case with the slip scrapers.



Installation in Michigan Mine Showing Car Spotted Under Loading Platform.

Fig. 1 is the box type, having sides and back. This works well in soft ore but on account of its sides it will not dig itself into lumpy material and it also tends to ride over the chunks. The average weight of these box type scrapers is 200 lb. and they will move approximately 7 or 8 cu. ft. of material per trip.

Fig. 2 shows the hoe type scraper. As it has no sides, or at the most very short ones, it does not tend to climb over the lumps as much as the box type and, therefore, works well in the coarser materials. Its weight and

capacity are about the same as those of the box scraper.

Fig. 3 is a heavier scraper, weighing about 500 lb. It is made reversible. The side having the teeth is used in combing the chunks off the pile first, then the scraper is turned over and the smooth side used for the finer ore.

Determining Type and Size of Scraper.—The proper size and type of scraper to be used will depend upon the way in which the ground breaks, and this in turn is largely governed by the size of the stope or drift in which the work is being done. In developing a scraper for handling a given kind of material, consideration

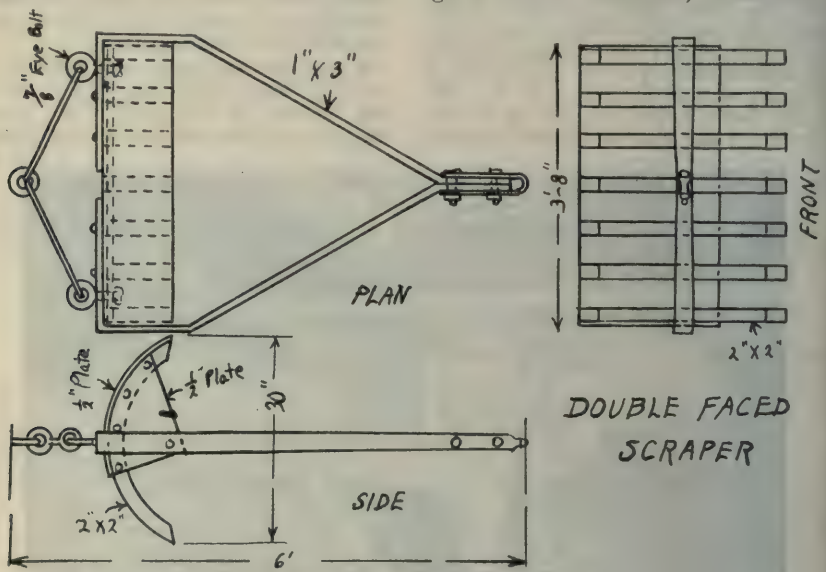
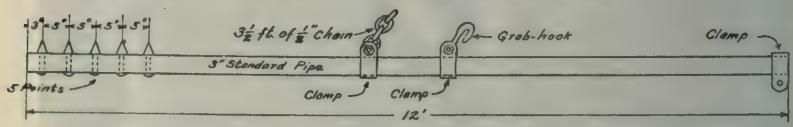
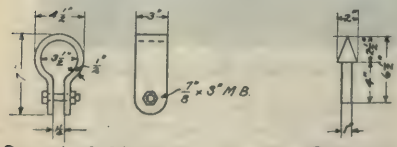


Fig. 3—Reversible or Double-Faced Scraper.



Boom.
Fig. 5.



Detail of Clamp
3 Wanted

Point
5 Wanted

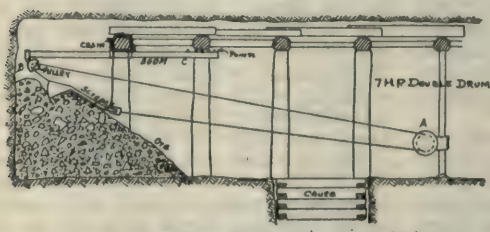
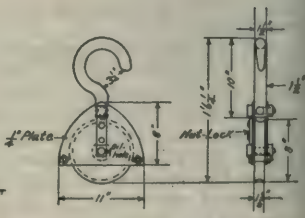


Fig. 4 Scraper Working in a Drift



Head-Sheave.
Fig. 6

Fig. 4—Arrangement of Scraper and Hoist for Slushing.

must be given to its size, to its weight, to the approximate pull on the rope, whether or not it should have sides, and whether or not the digging element should be a series of teeth or a single blade. The angle of the digging element must be determined so that it will be flat enough to dig into the pile, but not steep enough to climb over the material as the hoist starts to haul on the rope. Theoretically this digging angle should be in the plane of the resultant of the weight of the scraper and the pull on the rope. That is, if the rope pull were 400 lb. and the scraper weight 400 lb., the angle should be 450°. In practice the digging angle found most satisfactory for average conditions is about twenty degrees. Immediately back of this digging angle the blade must be curved upward. There are two reasons for this. If the blade were continued back at this flat angle of 20° the load would climb up onto the scraper and be carried along instead of being pushed along, and the weight of the ore on the scraper would tip it over backwards unless the bail or the sides were very heavily weighted ahead of the digging edge. The illustrations of the scrapers show this feature. The other reason for bending the blade upwards immediately back of the digging edge is because the scraper must be self dumping and the blade must be steep enough for the ore to drop off easily at the end of each trip.

The most general application of the portable double drum hoists has been for slushing ore into raises where the top slicing method of mining is used. Considerable progress is being made, however, in the utilization of this same equipment in development drifts and rock drifts for loading material directly into cars by scraping it up on an inclined plane that projects over the top of the car. In some cases a platform has been built at the top of the inclined plane long enough for two or three cars to pass under and the rock dropped through a hole in the platform.

Double Drum Hoist Operating Slusher Loading Rock Into Cars.

Mounting the Hoist.—There are a variety of ways for mounting the hoist itself. Probably the most usual method is to mount the machine on skids and sprag it down with ordinary timber sprags. An improvement over the ordinary timber skid is a metal turntable which permits the quick and easy movement of the machine around a king pin, so that the hoisting rope can always be hauled in and paid out

at right angles to the axis of the drums, thus preventing the rope from rubbing against the drum flanges, or climbing off from the drums. In the drifts the hoist is sometimes mounted on a vertical mining column, placed close to the side of the drift, either directly on the column itself or on a column arm.

One of the first fittings or auxiliary appliances to receive attention with the introduction of the double drum slusher was a satisfactory device for mounting the sheave wheel at the breast so that the tail rope could re-

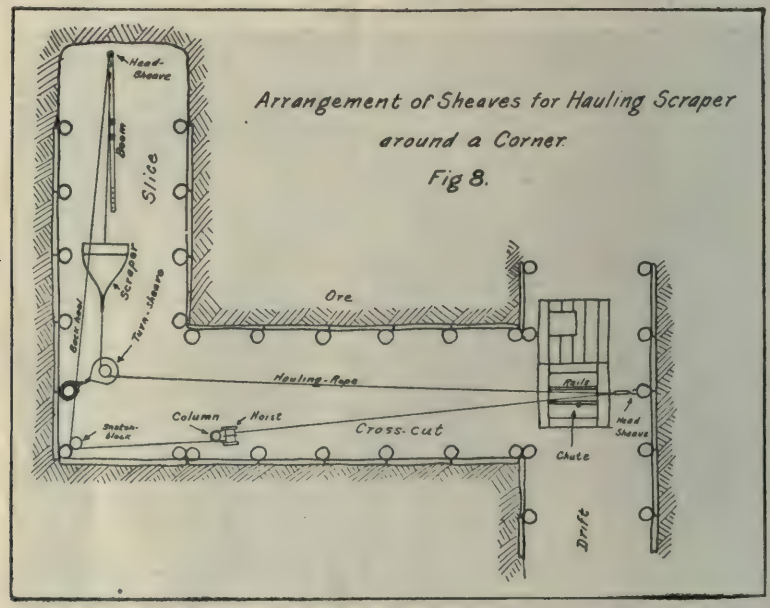


Fig. 5—Arrangement of Scraper, Sheaves and Hoist for Scraping with a 90° Turn.

turn the empty scraper to its proper starting position. There are three ways in which this can be done: First, if the working place is not timbered an ordinary light mining column or shaft bar is set up horizontally across the drift and close to the breast and then the sheave is attached to this with chains or clamps and is moved from side to side as is required. A second method is to stretch a chain across the drift instead of the column. Where the places are timbered the third method is to use a boom as illustrated in Fig. 4.

This boom is a piece of 3 or 4 in. pipe, 12 to 14 ft. long, with the sheave mounted at the end towards the breast. In about the center of its length is attached a short piece of ½ in. chain and a suitable hook. The boom is hung by this chain from the center of the timber cap of the set nearest the breast. The back end of the boom is pressed up against the under side of the cap of the second set, and is held in place by a series of teeth or sharp points along the top of the boom, which project upward against the cap. To move the sheave from side to side at the face it is only necessary to pull down on the back end of the boom and swing it to either side. This is usually done by the miner while the hoist is dragging in a load, as the tail rope is then slack.

Another auxiliary fitting that added materially in securing further service from the hoists was a simple device for tripping the rope off the turn sheave in slushing around a corner. Turns up to 45° can be made without the necessity of a sheave wheel at the turn for the haulage rope by nailing some upright boards to the timbers which will guide the scraper around the turn. Even here, however, a pulley or snatch block should be used for the tail rope so that it can be kept back out of the path of the scraper.

Fig. 5 shows the arrangement of

the hoist, sheaves, and ropes for slushing around a right angle turn. The hoist is set up at or near the turn instead of at the raise. The reason for this is that the hoist operator can more easily get the signals from the man at the face. He can also assist in putting the rope back on the turn sheaves, which is done either by hand or by using a short iron hook. For this right angle turn, a turn sheave is used to guide the haulage rope. The turn sheaves are made open on one side and the rope groove is shallow so that if a solid ball 3 or 4 in. in diameter is made fast to the haulage rope just in front of the scraper, this ball will trip the rope off the turn sheave when the scraper reaches the turn. The same thing is accomplished if a 6 or 8 in. diameter wheel is mounted on the scraper bail at the point where the rope is attached.

Other detailed features of equipment and methods of operation have received attention at various mines. Any tendency on the part of the scraper to dig into the bottom of the drift can be overcome by laying down light rails, not on ties, but made continuous with fish plates. If the raises are timbered the top timbers can be protected from the scraper as it dumps by laying a couple of bent rails across the top of the raise for the scraper to slide on. In slushing into cars the grade of the inclined plane is about one foot rise to three feet advance. The foot of the slide is located about 25 ft. back from the breast to allow distance enough for the scraper to take its load and to permit it to line up with the center of the slide before starting up.

Front View of Slushing Framework With Scraper Hauling a Load Up It.

Economy of Slushing.—The results that are being secured in slushing ore with the double drum hoists in the Lake Superior district are very satisfactory. For best results the length of haul should be under 100 ft. and the average capacity will then be 25 to 30 tons per hour. Good work is being done at distances up to 200 ft., however, but the capacity per hour is materially less. On the average the cost per ton of slushing ore is one-half the cost of hand shoveling and tramming. Under favorable conditions the saving is even greater.

Construction News of the Railways

Nickel Plate to Double Track

The New York, Chicago & St. Louis R. R. contemplates completing double tracking its line between Buffalo and Chicago within the next 3 or 4 years. With 30 miles of new second track now being added and that used under the trackage agreements, the Nickel Plate will have about 160 miles of double track between Buffalo and Chicago in use this winter or about one-third of the distance.

New Logging Road in Georgia

The Davis-Zirkle Lumber Co., of which L. A. Zirkle, Zirkle, Ga., is vice president, will build a standard gage logging railroad from the A. B. & A. R. R. at Goffee, Ga., to a tract of yellow pin timber recently bought in Pierce and Bacon counties.

Southern Pacific to Drive 2-Mile Tunnel

The Southern Pacific R. R., according to San Francisco advices, will start work at once with company forces on driving a 2-mile tunnel through the summit of the Sierras on the Ogden route. The western portal of the single-track bore will be west of Summitt and the eastern portal near Lakeview, on the immediate east side of the mountains' crest. The project will cost approximately $3,000,000. The project is a unit in the double-tracking of the 28 miles of the route between Emigrant Gap and Andover. The new or second track leading to the wastern portal will leave the present track west of Summit. The tunnel will parallel the present track to the west end of Lakeview. It will go under the present track at Lakeview. The tunnel track will be used for the eastern movement and the present track for the western movement of traffic. Routing of the new or double-track through the tunnel, will do away with the trouble and cost of snow-shed maintenance.

Southern Pacific to Erect New Station in Sacramento

The Southern Pacific R. R. will begin construction soon on a new passenger station at Sacramento, Calif., to be located at 4th and H Sts., facing toward I St. The main building will be on H St., facing south, with the center on 4th St., and extending half a black east and half a block west. On the front and rear of the building there will be a marquise. East of the main building a mail building will be constructed and northeast of the mail building will be an express building. This will leave the main building for passenger traffic exclusively. West of the station will be a Pullman car shed.

Western Pacific May Widen Salt Lake Fill

Surveys have been made by the Western Pacific R. R. for widening its 10 mile fill across Great Salt Lake in Utah.

Grade Crossing Elimination in Beaumont, Tex.

The first constructive step in the program for the elimination of the grade crossing menace in Beaumont was taken when the city commission authorized Mayor B. A. Steinhagen to continue his negotiations with the officials of the Southern Pacific R. R. and when certain minor phases of the document have been adjusted to enter into a contract with the railroad company for the erection of the proposed Mariposa St. viaduct.

Track Elevation at Hammond, Ind., Will Cost $6,000,000

Elevation of the four principal railroads through the heart of Hammond will cost $6,000,000, according to estimates of railroad engineers which were submitted to the board of works and track elimination committee of the chamber of commerce. The cost estimates, which are the maximum, follow: "The Erie $2,260,000, covering from the Michigan Central railroad to Douglas St. and running off to the Calumet river and Highland St.; the Nickel Plate, $1,018,000 elevating from the Michigan Central to Columbia Ave. and running off to the Calumet river on the north and to the east to Columbia Ave.; the Monon, $1,017,602, elevating from the Michigan Central to Douglas St. and running off to Calumet river on the north and Highland St. on the south; the Michigan Central, $1,750,000, from Hohman St. to Calumet Ave. and running off to Columbia Ave. on the east and Freeland Ave. on the west.

New Coal Road in Indiana

The Evansville, Indianapolis & Terre Haute Ry. has asked the Interstate Commerce Commission to authorize construction of 6 miles of new line from a point in Gibson county, Ind., on the main line to a connection with the Southern Ry. at Oakland City, Ind. The new line will open strip-mining territory heretofore undeveloped.

New Municipal Street Railway Line at San Francisco

The Supervisors of San Francisco, Calif., have authorized the preparation of plans and specifications for a street railway line on Judah St., from Cole and Carl Sts. to the beach.

Moffat Tunnel Contract Let

The contract for the construction of the Moffat Tunnel near Denver, Colo., was let last month to F. C. Hitchcock, of New York and C. C. Tinkler of San Francisco. The cost is placed at $5,250,000. Mr. Tinkler lived in Denver from 1900 to 1912 and was the builder of 15 tunnels on the Moffat road; he built tunnels for several American roads as well as the roads themselves, and has built railroad and power tunnels in various parts of the United States and Canada. Mr. Hitchcock is president of the Carey-Campbell Co., New York; vice-president of the W. F. Carey Co. and an officer in other big construction concerns. He spent three years in construction work in China and was formerly vice-president of MacArthur Brothers.

New Great Northern Line Proposed

Advices from St. Paul, Minn., state that construction of a new line, permitting the linking of Yankton, S. D., and Sydney, Neb., and providing a new route between the Twin Cities and Denver, Colo., shorter by 115 miles, is contemplated by the Great Northern and Burlington railways in the event these systems and the Northern Pacific are consolidated as requested of the Interstate Commerce Commission. Approximately 200 miles of new line costing $5,000,000 would be required to make the extension of the Great Northern from Yankton to Plainview, Neb. The existing line of the Burlington would give entrance into O'Neill, Neb., and the Burlington would have to extend its line to Thedford, Neb., and from Mullen to Sydney, Neb., to complete the new route.

L. & N. Track Revision Job in Kentucky

Louisville & Nashville R. R. is reported to have taken bids on a $500,000 job for reconstruction work involving straightening out of curves and making fill-ins at trestles over ravines on Muldraugh Hill, in Hardin County, Ky., between Colesburg and Tunnel Hill. A year or more will be required to complete the work, which affects that part of Muldraugh Hill or the Cumberland Plateau running from the beginning of the grade at Colesburg to the summit at Tunnel Hill.

Grade Crossing Elimination at Columbus

Construction will be started next spring on the two remaining projects of the Columbus, O. grade crossing elimination program. The estimate of the city's portion of the expense of eliminating the Norfolk & Western crossing is $450,000 and the Dennison Ave. crossing $400,000.

Florida East Coast R. R. to Build Shops at Bowden, Fla.

The Florida East Coast R. R., proposes the expenditure of $1,500,000 for the establishment of a terminal and shops at Bowden, 7 miles south of South Jacksonville, Fla.

Toledo, O., to Vote on $3,000,000 Bond Issue for Grade Separation

The citizens of Toledo, O., will vote at the November election on a $3,000,000 bond issue for the city's share of the cost of 15 grade separation projects. This program is to cover 10 years. The city's share will be $2,028,000 and the railroad's, $3,737,000.

New Railroad from Hattiesburg to Columbia, Miss.

A plan is under consideration for building a railroad from Hattiesburg to Columbia, Miss. Mayor W. S. F. Tatum of Hattiesburg, Miss., is reported interested. Mr. Tatum owns a standard gauge log line that extends 22 miles virtually in the direction of Columbia. Should he extend his line he would have to make certain changes in the log line beyond the 14 mile post from Hattiesburg or else construct a new line. By using the facilities now in existence, it was said, a line could be run into Columbia by building 14 miles of track.

Tunnel Construction for Carrying Oil Pipe Line Under Canal

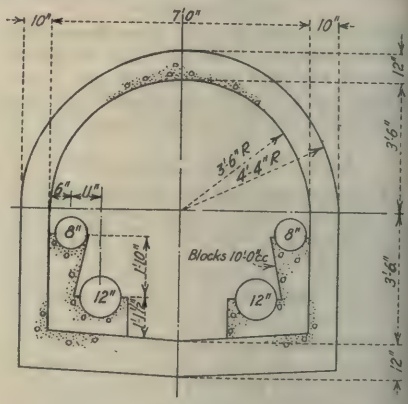
Inverted Siphon Crossing Under Indiana Harbor Canal at East Chicago, Ind., Built for Sinclair Pipe Line Co.

An inverted siphon under the Indiana Harbor Canal, near White Oak Ave., East Chicago, Ind. is required to carry the oil pipe lines from the Wyoming, Kansas and Oklahoma fields to the refineries at Whiting and East Chicago, Ind. The siphon was constructed in order to avoid changes due to dredging in the canal and also to have the pipes accessible for repairs and to avoid deterioration of the pipe due to chemicals in the canal water. The siphon was designed to carry 2 12 in. and 2 8 in. pipes.

The crossing is an arch top tunnel 7 ft. x 7 ft., with a short section of 10 ft. x 10 ft. section at the North shaft to facilitate the handling and assembling of the pipe. Entrance is made to the tunnel by two 10 ft. diameter concrete lined shafts about 65 ft. deep.

All of the excavation from the tunnel was taken out at the South shaft and was piled near and will be used as a top covering for the fire walls of the adjacent tank farms.

Shafts.—The shafts were 13 ft. in outside diameter and 10 ft. inside the concrete lining. The first 25 ft. of excavation was soft tough clay containing a few small stones, but on the North shaft the material was slightly different, as the South half of the shaft was very hard tough clay while the North half or about 5 ft. was black



Section of Tunnel.

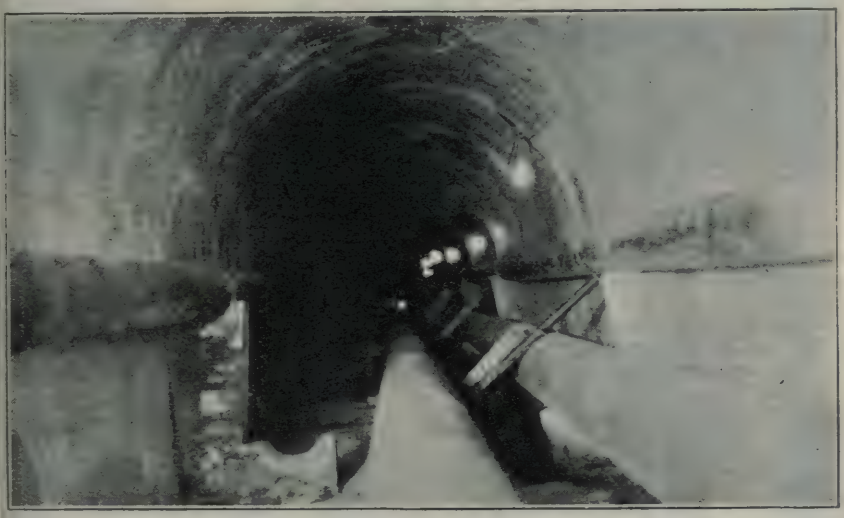
Forms for Shafts for Inverted Siphon Crossing Under Indiana Harbor Canal.

muck in which several small red cedar logs were encountered. The remainder of the shafts were tough clay containing a large percentage of small pieces of stone and slate. Little water was encountered after the shafts were sunk a distance of 10 ft. into the clay.

Wood sectional forms in 4 ft. sections were used in the forming of the concrete lining. A cutting edge was used on both shafts made of angle 4 x 4 x ½ and a 24 in. x $\frac{3}{16}$ in. plate, with ⅝ in. x 36 in. anchors spaced 24 in. apart. The concrete was reinforced both horizontally and vertical with ½ in. square bars spaced 24 in. c to c.

8 x 10 steam hoisting engine. Concrete was mixed in a ½ yd. gasoline driven concrete mixer and placed in the forms with the derrick and a bottom dump bucket. Water was supplied from the pump on the South side of the canal through an 1¼ in. pipe laid across on the bottom of the canal.

The shafts were sunk by the open dredging method to near the top of the tunnel and were then underpinned to the bottom, several small washings occurred in both shafts caused by sticks and flat stones getting under the cutting edge and cutting a small channel on the outside of the shell.



View of Tunnel, Showing Method of Carrying Two 12-in. and Two 8-in. Pipes.

The equipment for the South shaft consisted of a traveling derrick lift gage with a 40 ft. boom for handling a ½ yd. clam-shell bucket, operated by a 7 x 10 D. C. D. D. steam hoisting engine, air for the pneumatic shovels used in excavating and for ventilating the tunnel was supplied by a 10 x 10 steam air compressor and with a 60 in. x 6 ft. air receiver, steam was supplied to run the compressor by the boiler of the hoisting engine. Water was supplied for the work by a 2 in. gasoline pump connected to well points.

Concrete was mixed in a ½ yd. gasoline concrete mixer and placed in the forms with the derrick and a bottom dump bucket.

The equipment for the North shaft consisted of a 60 ft. guy derrick with a 50 ft. boom handling a ½ yd. clam-shell bucket and operated by a 3 drum

Two sets of forms were used for each shaft and forms were left in place 48 hours.

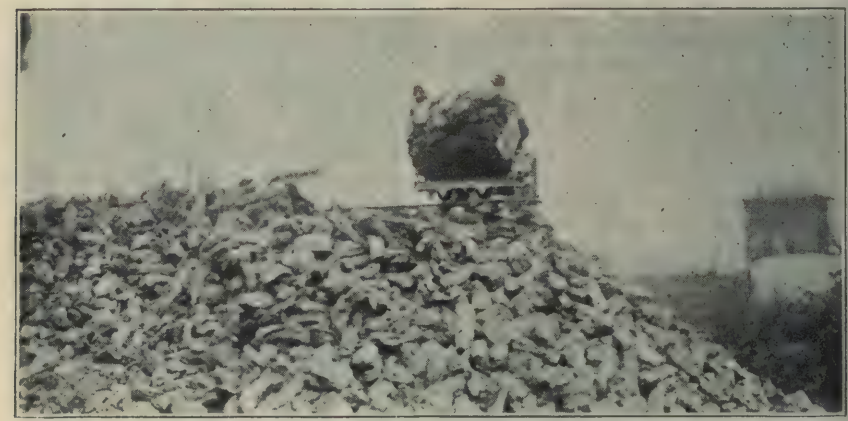
Tunneling.—Tunnel excavation was handled from the South shaft and was nearly all in tough hard clay containing slate and small stone. In this material the ordinary method was to mine and concrete 6 ft. in a shift of 9 hrs. and two shifts were operated so that the progress was 12 ft. per day. A few small sand pockets were encountered and where these occurred mining, timbering and concreting was done in 3 ft. sections. Three pneumatic shovels were used in the heading and the muck was handled by 2 muckers and 2 car pushers.

Steel ribs made of two pieces of 6 in. channel with angle lugs at top and bottom for bolting together and 2 x 6 in. wood legging with beveled edges were used for the forms for the con-

crete lining. The excavated material was handled in ¼ yd. steel V shaped side dump cars on a track of 16 lb. rail 14 in. gage resting on 4 x 4 x 36 in. ties spaced 3 ft. c to c. The cars were handled on a 5 x 4 ft. elevator operated by the steam hoist.

Gravel concrete was used for all of the work of a 1, 2½, 4 mix, the concrete for the tunnel being handled by the ½ yd. steel dump cars and then shoveled and tamped into the forms. A medium dry mix was used for the tunnel. Concrete inserts were spaced 10 ft. apart in the tunnel and shafts to provide for future pipe supports.

Lines for the tunnel were established with heavy plumb bobs suspended in the shafts, and lines and grades were established by the contractor. The work was commenced on June 16th and the tunnel was holed through Sept. 15th. The estimated cost of the work was about $100,000.



Muck Pile at South Shaft, Showing Character of Excavated Material.

The siphon was designed and constructed by the Subway Engineering Co. of Chicago, Ill. for the Sinclair Pipe Line Co. of Tulsa, Okla. The work was under the general supervision of the following Sinclair Pipe Line Company's engineers, Frank Hadley, Chief Engineer, W. E. Brewer, Division Engineer and H. S. Joyce, Resident Engineer.

Arrangement for Concreting Shafts and Tunnel.

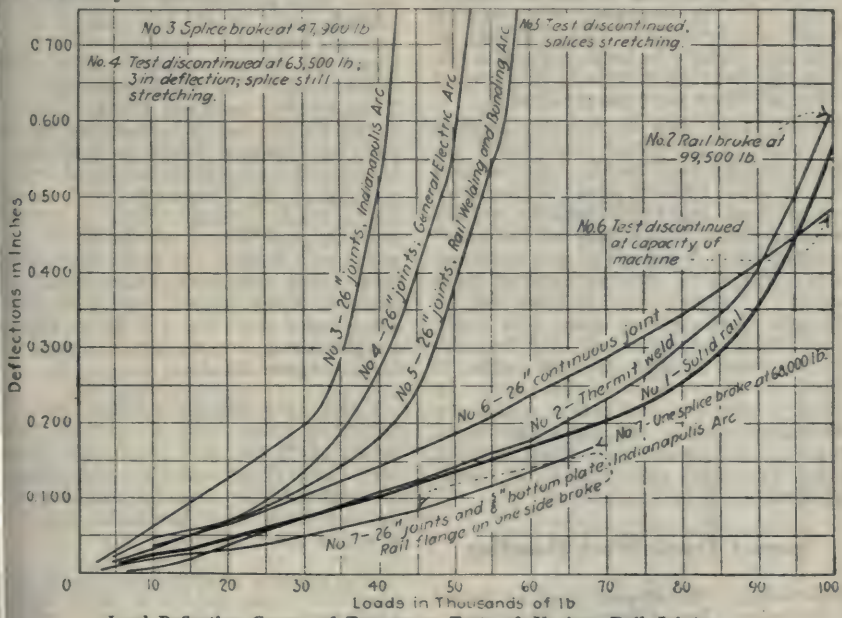
Tests of Welded Rail Joints

Results of Investigation Made at Iowa State College.

Some interesting tests of rail joints were made last year at the Engineering Experiment Station of the Iowa State College. The tests and the results formed the basis of a paper presented Sept. 6 before the Iowa Electric Railway Association by W. L. Wilson, Chief Engineer, Des Moines City Ry. The following abstract of the paper is reprinted from the Electric Railway Journal:

lb. testing machine. This was the largest machine available at Ames and in order to stress the various sample joints sufficiently to obtain good results it was necessary, on account of the low capacity of the machine, to support the test pieces on 60 in. centers. This was longer than desired, but the results obtained gave good comparative data anyhow. Deflections were read by a Riehle deflectometer, reading to one-thousandth of an inch, and readings were taken at increments of 5,000 to 10,000 lb. loads, applied midway between supports.

The results of the tests have been



Load Deflection Curves of Transverse Tests of Various Rail Joints.

The following tests were made:. 1. Solid piece of rail with no joint. 2. Thermit weld. 3. Seam weld, side plate only, Indianapolis arc. 4. Seam weld, side plates only, General Electric arc. 5. Seam weld, side plates only, Rail Welding & Bonding arc. 6. Bolted continuous joint. 7. Seam side weld, side plates and base plate, Indianapolis arc.

In order that there should be no error due to differences in the rail itself all pieces used in the tests were cut from the same rail, th section being 7 in., 8-lb. Tee, H. S. Co. No. 335.

The solid rail was 6 ft. long and each sample joint consisted of two 3 ft. pieces, welded or bolted together. All tests were made on a Riehle 100,000

plotted and are shown in the accompanying chart.

Test No. 6 is an interesting one, being that of a standard 26 in. continuous rail joint held by six 1 in. x 4½ in. heat-treated bolts having Harvey grip threads and Ideal received nuts. This joint has been the standard in use by the Des Moines City Railway for a number of years previous to 1922.

Length of Weld Plates Makes Little Difference.—The primary object in making these tests was to determine which kind of arc or electrode or which polarity of the electrode was best, but the results, so far as I can see, indicate very little if any difference. Neither does the length of weld

plates make much difference, except of course in cases of very short plates. The addition of a base plate, however, does seem very materially to increase the stiffness of a joint.

It has been and still is my opinion that the personal equation or workmanship has a very great deal to do with the life of rail joints. A poorly designed joint, carefully and thoroughly applied, might last much longer than the best type of joint poorly applied. Many plain bolted joints can be found in almost perfect condition after several years of service, while perfectly good continuous joints with heat-treated bolts can be found commencing to fail in a year or less, due simply to lack of care in fitting up, clearing rail ends, tightening bolts or other poor workmanship.

This same line of thought applies not only to the bolted joint but I believe equally well to the seam-welded or any other type of joint. So we must not sit back and think because we are welding joints today that we are eliminating most if not all of our troubles. The question is, Are we getting good welds? Furthermore, it must not be thought that welding alone will make good track out of track that because of improper design for the traffic it must carry never could be good. In other words, welded joints alone are worthless unless we have the right type of rail, good ties, good ballast, good drainage and, above all, good workmanship in everything.

Special Track Work Bonding

Practices of the Department of Street Railways, City of Detroit, Described in Traction Junior

Standardization of bonding, in so far as it is practicable, has been introduced on the municipal railways in Detroit. Under the supervision of H. M. Gould, electrical engineer, many of the typical layouts have been standardized and all work falling within the classifications is now done in a uniform and approved manner.

The standard crossover presents little difficulty in bonding work, but for comparison of methods, the practice in Detroit is of interest. In general the practice consists of connecting a 1,000,000 c. m. bare copper cable to both rails at a point ahead of the switch point by means of three 4/0 66 in. cross bonds soldered to the main cable. The main cables are run down the center of the track to a point beyond the frog and are here connected to rails by means of three cross bonds similar to those used ahead of the switch point. All rail joints are bonded with number 4/0 38-in. copper welded bonds. Two tie bonds between inside rails of main tracks at a point opposite the extreme ends of the main cable, tie the track circuits together.

The standard Y layout is bonded by main cables laid in the form of a T with a soldered joint at the intersection. The vertical leg of the T is installed only when the single track extends beyond the special work more than 100 ft. or connects with other track work. The horizontal leg of the T. is located between tracks from P. S. to P. S. and is connected to the rails by soldered joints to three cross bonds. As an additional bond where one leg of the Y connects with second main track, a main cable is carried from a point ahead of the P. S. to a point well behind the frog, connecting into three standard cross bonds at each of these places. All rail joints are bonded with No. 4/0 38-in. welded copper bonds, cross bonds being 4/0 66-in. copper bonds.

Cables are laid in trunking and the trunking filled with a mixture composed of 75 per cent pitch and 25 per cent tar. Short cables which cannot be conveniently laid in trunking are painted with black insulating paint as are also the 4/0 bonds.

The general scheme consists of running two main cables of bare copper 1,000,000 c. m. between main tracks in both directions and connected at each end by cross bonds and inside rail bond connections at points beyond used at intersections of cables and welded copper bonds at all rail joints. the special work. Soldered joints are

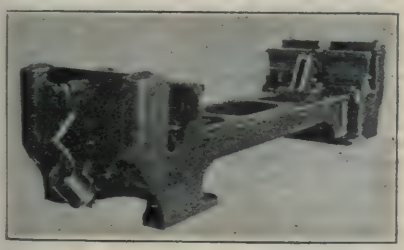
The department of street railways of Detroit very carefully carries out all of the bonding work at each special work location and drawings are made in every instance, even in the case of the simplest layout such as a right angle single track crossing. It is realized that these points present opportunities for trouble and losses, and consequently great care is used in the initial installation. Excellent results have been accomplished for this reason.

New Device for Testing Wheel Impact on Rails

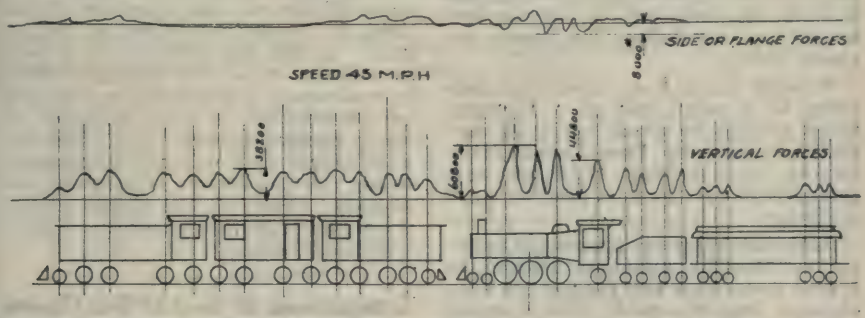
An interesting device known as an otheograph which is in effect a test tie for measuring simultaneously the vertical and transverse trust or impact of a wheel on a rail, has been recently developed by the General Electric Company, Schenectady, N. Y., and a number of these ties are being installed on the company's test tracks at Erie, Pa. The instrument shows by graphic records the effect of each separate wheel of a locomotive or car on each of the two rails.

We are indebted to the Railway Age for the following particulars:

These otheograph ties may be installed in place of the regular ties, either singly or several grouped together on curves or tangent track. Provision is made for the use of two different springs for recording the vertical load, one having a deflection of about ⅛ in. for each 25,000 lb. of axle loading, and the other spring having the same deflection for each 50,000 lb. of axle loading. The springs are designed for a maximum deflection of ⅜ in. The springs for recording the transverse thrust have deflections of about ⅛ in. for each 20,000 lb. The deflection of the spring is recorded through a lever having a ratio of 8 to 1, the record being traced on paper wrapped around a revolving cylinder similar to an engine indicator. The operating mechanism provides for moving the recording cylinders on any number of ties simultaneously so that as many records may be taken of each wheel on each side of the locomotive as there are ties that are grouped together.



General View of the Otheograph Tie.



Experimental Record Made of a Test on C. M. & St. P. Electric and Pacific Type Steam Locomotive Coupled Together. Figures Show Approximate Stresses in Pounds.

Suggestions for Ditch Blasters

Some helpful hints for blasting ditches with dynamite are given in a recent issue of The Du Pont Magazine, from which we quote the following:

Creditable work calls for careful preparation. Particularly is this true of ditch-blasting by the propagation method. If you would blast a straight, trim, clean-cut ditch, make sure the ditch line is straight at the outset, space the holes uniformly, punch them to an approximately uniform depth, grade considered, and load accordingly. Unless there is a variation in the character or moisture content of the soil, unless rocks, stumps or other obstructions are encountered which necessitate special preparation, uniform loading can usually be relied upon to give uniform results.

A stout cord—stretched taut between wooden stakes along the ditch line and parallel to grade—is a dependable guide for keeping the holes in alignment. And one of the best

ways to have the holes spaced regularly is to crimp double-pointed copper rivets to the cord at required intervals, so that when the cord is in position each rivet will show where a hole is to be punched.

Of course, if the ditch line is comparatively short, the practice of fastening the rivets on the cord is hardly warranted; but if it is proposed to blast a ditch several hundred yards long, the time required to prepare the cord in this manner is usually well invested. For ditches of short length, many professional blasters merely use a stick of wood cut to the desired length for regulating the space between holes.

Wooden punch-bars, gradually tapering to a point, and of a diameter large enough to admit a 1¼ in. cartridge, have been found most satisfactory for making holes in soft ground. In hard ground steel bars are necessary.

After the holes are punched it is important that the dynamite charges be forced down into the ground an even distance from the cord. This is easily done by the simple expedient of cutting a notch on the tamping stick as a guide in pushing the charge in place.

It is good practice to pour a little water in the holes, if no water is encountered, in order to punch them more easily. After loading, it is a good plan to fill the holes with water to act as tamping and also to assist propagation.

Autobusses in Holland

A large increase has developed in autobus line in Holland in the past few months, Consul General George E. Anderson informs the U. S. Department of Commerce. The entire country has been covered with a network of lines which includes not only interurban services but intraurban, in competition with local tram lines. The movement is having a marked effect on railway business earnings in the suburban and interurban business and now has begun to effect intra-mural street car revenues. The development is greatest in the vicinity of Rotterdam, Amsterdam, and the Hague, but is becoming important in and around Utrecht, Delft, Leiden, Arnheim, and in the far north at Groningen. In Rotterdam a total of 39 licenses to establish and maintain municipal bus services have been granted, 22 for service entirely inside the city limits and 17 for urban, suburban, and interurban services. The licenses cover 47 city lines, and 58 outside the city. Not all the licences have begun operations, but about 90 per cent of the enterprises are actively operating. The suburban and interurban run in all directions from the city and connect every town of any consequence within a radius of 17 kilometers with the center of Rotterdam city. The longest run is to the famous bulb fields northeast of the city and is intended to facilitate the flower industry. It costs 48 cts. to ride from the flower fields to the central market of Rotterdam. In the city services have been established on all the principal routes in most cases supplementing the tram car services but in some instances directly competing with them. The cars used range from ordinary automobiles to big German busses holding 26 passengers. Most of the busses are of American make, or American chassis with local bodies.

Comparison of Cost of Bus Operation with Electric Car Operation

The following information on this subject was given in the report of the Committee on Bus Operation presented Oct. 10 at annual convention of the American Electric Railway Association: The most important factor to bear in mind in comparing the cost of bus operation with that of electric car operation is that by reason of the smaller seating capacity of the bus, the cost per passenger is considerably higher than for electric car operation. The average cost per bus mile, including taxes and estimated depreciation, based on the figures furnished to the committee is 24.6 cts. As no results from the operation of double-deck buses are included in these figures, it is fair to assume the average seating capacity per bus to be 25. On this basis, the cost per seat mile of bus operation is 0.98 cts. Data obtained from 10 companies operationg one-man trolley cars, exclusively, shows an average cost per car mile of 25.7 cts. including depreciation, actually charged, based upon the estimated life of the equipment and taxes. The cars of these companies have an average seating capacity of 42, resulting in a cost per seat mile of 0.61 cts. These figures, however, do not include a return on the value of the property.

Buildings

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.

221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*

LEWIS S. LOUER, *Vice-President and General Manager*

New York Office: 904 Longacre Bldg., 42d St. and Broadway

RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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Vol. LX. CHICAGO, ILL., OCTOBER 24, 1923 No. 4

The "Ready-Cut" House

The purchaser of anything from a movie ticket to a railroad seeks the greatest possible value for his money. This "greatest value," however, is seldom a simple thing. One's favorite movie star, for instance, may be showing at a theater which is conveniently located but where the music is notoriously poor and in a play in which one has no great interest. At another theater the merits and demerits may be reversed; and if one has decided upon an evening's entertainment of this sort he will select that performance which, all things considered, he believes will give him the greatest net satisfaction.

So it is with all things, and nowhere more so than in acquiring a home. From cottage to palace the builder balances and compromises his desires to get the most for his money. With a host of qualities including space, convenience, durability and attractiveness he wants also individuality. But individuality, like other qualities, is largely a matter of degree; and unless his means be great he is likely to have to sacrifice some of it which he would wish to keep.

The ready-cut house is popularly supposed to lack individuality, but the fact is that the better "ready-cuts" are not more stereotyped than are many houses built from materials cut on the job; while they are distinctly better looking than thousands of individual designs whose makers and purchasers would resent any criticism of their artistic merits.

We do not deny the desirability of an original design for every home builder. Plate glass and hardwood floors throughout are also obviously desirable, but the majority of builders in conforming their requirements to their means, dispense with them. The sacrifice of a measure of individuality through the use of ready-cut materials must be treated as are other necessary sacrifices, and with due consideration of the advantages made possible in other features by the savings effected in this one.

There is a great difference in the saving of an architect's fee through the use of publisher plans, and the saving to be derived from the system here considered. The former, at best, is but a part of the latter; and very often the owner's effort to supply the architect's services of organization and supervision wastes more than was saved on the cost of preparing plans. The ready-cut system raises the savings to a worth-while scale, and also makes it easier to dispense with an architect's supervision.

Elsewhere in this issue we publish an illustrated account of a system of ready-cut buildings of attractive, modern design, and containing improvements over certain earlier system in the matter of work plans and the indexing and sorting of materials. Such systems with their conspicuous savings in "waste" material will undoubtedly find an increasing use as timber grows scarcer and more costly.

Some Advances in Structural Designing Practice

Editorial in The Canadian Engineer.

In the revision of the tentative standard specification of the American Institute of Steel Construction for the design, fabrication and erection of structural steel for buildings, some important changes were made. It was desired by the Institute to make the new specifications thoroughly up-to-date in every particular and as economical of material as sound theory and thorough experimental investigation would warrant. The result is that the final document, which has now received a very large distribution, may be considered to represent the most recent word on structural steel practice as viewed from the manufacturers' and fabricators' angle.

One important point upon which new ground has been broken is the question of wind stresses in buildings. Whereas in other specifications it is stated that the building as completed must be capable of withstanding a specified applied wind load, in the specification under consideration it is provided that the steel frame itself must be proportioned to carry a wind pressure of not less than 20 lb. per sq. ft. on the vertical projection of exposed services during erection and 15 lb. per sq. ft. on the vertical projection of the finished structure. Heretofore, it has been the practice of engineers to make some kind of estimate as to how much of the wind force was absorbed by walls and partitions and by the general inertia of the structure itself. The result has been a wide difference in practice as to the amount of wind force to be provided for in the frame. With the new specification, however, this will become a perfectly determinate matter and designers under it would always provide for the same amount of wind force for a given building. Whether the frame is being proportioned for a sufficiently large percentage of the total probable external wind force may perhaps be questioned by some engineers. In a situation where a force of 30 lb. per sq. ft. might conceivably exist, the present specification would in effect leave one-half of this wind force to be absorbed by walls, partitions and general rigidity. However, if 20 lb. per sq. ft. is a reasonable amount, then only one-quarter of the applied force would be left to be absorbed by other agencies than the frame members themselves. However, the principle adopted by the framers of the specification is a good one and doubtless it will establish a precedent which will be felt in subsequent specifications.

Tests carried out under the auspices of the Institute on both rolled beams and plate girders have been basis for a considerable increase in allowable web shear as compared with the first draft of the specification. The permissible stresses now allowed are higher than have heretofore been sanctioned by any of the common authorities. They agree with tests which were conducted previously to those of the Institute only in the case of girders with large ratios of depth in thickness. The stresses allowed under the new specification are two or three times greater than those allowed by the well-known Cambria web-crippling formula. However, the committee framing the specification feels that its investigations warrant the new formula and the consequence is that there will be a substantial lightening of webs brought about if this specification becomes generally current.

In accordance with the observations made in recent years by structural engineers with respect to the satisfactory behavior of bolts in steel work, the specification has been amended to provide for the use of

bolts in secondary parts of structures and in small structures such as shelters and the like for which the stresses are not important. The Canadian Engineer has on previous occasions advocated the greater use of bolts in relatively unimportant work and it is gratifying to find that in an important new specification is moving in this direction.

Applications for Space at Chicago Road Show Must Be In by Oct. 27

Applications for space at the Road Show to be held by the American Road Builders' Association in Chicago Jan. 14th to 18th, 1924, have been coming in in even greater volume than was the case a year ago. Allotment for this space will be made on Nov. 1st, and prospective exhibitors who wish their applications to be considered at this time must have them in the hands of Charles M. Upham, Convention and Show Manager, American Road Builders' Association, Raleigh, N. C., not later than Oct. 27th. The application blanks were sent out some time ago, but additonal blanks may be obtained by writing to Mr. Upham.

The meeting in Chicago on Nov. 1st at which the space will be allotted will be confined to the members of the Executive Committee of the American Road Builders' Association, the Executive Committee and representatives of the Highway Industries Exhibitors' Association and the Advisory Committee of the Exhibitors' Committee. On account of the large number of applications and the limited space available, it has been found necessary to restrict the attendance at this meeting to the committees named above.

New Micrometer for Accurate Measurements

A micrometer of extraordinary accuracy has been constructed by the U. S. Bureau of Standards for determining the diameter of some 12-in. porcelain cylinders to be used in electrical measurements. Measurements made with the new instrument are independent of the observer and have an accuracy of 0.0001 of an inch. In order to obtain this degree of accuracy, it is necessary to operate the micrometer from a distance and to take readings from it through a telescope so that the heat of the observer's body will not warp the thick iron ring enough to cause an error. Both the instrument and the cylinder which it is employed to measure must be kept in a constant-temperature box during the measurement. The micrometer consists of a cast iron ring large enough to pass easily over the 12-in. cylinders. On opposite sides are the micrometer screw and adjustable lugs for centering the device on the cylinder. The micrometer screw is driven by a tiny electric motor and the ring with its attachment, including the motor, is suspended by three light rods and can move freely for a short distance.

In making a measurement the micrometer screw is revolved by the motor through a train of gears, the motion of the screw pushes the cylinder against the contact pin and when this contact is made, the motor circuit is broken thus stopping the screw. The cylinders which are to be measured will be wound with wire on a precision lathe and will form inductance coils of very accurate construction, the inductance of which can be calculated from the dimensions. They will be used for research work in a program for standardizing all of the electrical units in terms of the fundamental standards of length, mass, and time.

Effect of Spacers on the Bonding Strength of Masonry

Spacers are sometimes used between the stones in masonry construction to insure joints between courses of uniform thickness. One of the materials used for this purpose is sheet lead cut into small squares or octagon shapes. Wood is also occasionally employed. In practice these spacers are placed on top of each course before the mortar is spread, and the question has arisen as to whether this affects the bonding strength of the mortar. In order to obtain information on this point, the U. S. Bureau of Standards has conducted some preliminary tests, using limestone bonded together with a natural cement and with lead buttons and wood spacers. The results thus far obtained indicate that these spacers seriously interfere with the bonding of the cement. This is probably due to the fact that the spacers hold the stones apart so that the mortar in setting shrinks away from the stone.

Retail Prices of Building Materials

Average prices paid Sept. 1, 1923, by contractors for building materials delivered on the job. These prices are secured through the Bureau of the Census and published monthly by the Division of Building and Housing of the Bureau of Standards, United States Department of Commerce.

The report as published by the Division of Building and Housing gives prices at 42 cities, 27 of which are included in the table herewith. Boston, New York, Philadelphia, Chicago and San Francisco are among the places not listed in the Bureau's report for Sept. 1.

Item No.	Commodity. Size and condition.	Unit.	Haverhill, Mass.	New London, Conn.	Poughkeepsie, N. Y.	Rochester, N. Y.	Buffalo, N. Y.	Baltimore, Md.	Richmond, Va.	Columbia, S. C.	Savannah, Ga.	New Orleans, La.
1.	Common brick	1,000	$24.00	$32.00	$20.00	$17.75	$23.00	$20.00	$19.00	$12.00	$17.50	$17.00
2.	Portland cement, excl. of containers	Bbl.	3.60	3.20	2.90	3.35	3.03	2.82	3.50	3.60	3.85	3.00
3a.	Yellow pine, No. 1, dimension 2x4—16′, S1S1E	M	80.00	75.00	.....	48.00	55.00	40.00	32.00	.....	30.00	42.00
3b.	Douglas fir, No. 1, dimension 2x4—16′, S1S1E	M	.....	.....	43.00	56.00	60.00	.....	.....	.....	.....	.....
3c.	N. Carolina pine, No. 1, dimension 2x4—16′, S1S1E	M	.....	50.00	43.00	48.00	.....	.....	.....	27.50	.....	.....
4.	Common boards, No. 1, 1x6	M	55.00	46.00	43.00	45.00	50.00	50.00	32.00	26.00	30.00	42.00
5a.	Y. P. flooring edge, grain "C," 1x4—10′—16′	M	130.00	110.00	130.00	130.00	85.00	.....	70.00	100.00	.....	.....
5b.	Douglas fir V. G., No. 2, 1x4—10′—16′	M	.....	.....	.....	.....	115.00	.....	.....	.....	.....	.....
6a.	Red cedar shingles, extra clear, 16″, 5 to 2	100 sq. ft.	6.40	6.00	7.20	6.25	6.75	11.20	7.20	.....	.....	.....
6b.	Cypress shingles, extra clear, 16″, 5 to 2	100 sq. ft.	.....	.....	.....	.....	.....	.....	.....	.....	7.60	7.50
6c.	Composition shingles, crushed slate surfaced	100 sq. ft.	.....	.....	6.00	.....	.....	6.00	5.48	6.25	6.50	.....
7.	Gypsum plaster board, ⅜″	1,000 sq. ft.	50.00	50.00	50.00	30.00	45.00	32.50	40.00	35.00	40.00	45.00
8.	Lime, HYD, com	Ton	20.00	26.00	22.00	20.00	16.00	15.00	17.50	18.50	22.50	.....
9.	Building sand	Cu. Yd.	3.00	1.50	2.50	2.25	1.28	2.50	.....	1.25	2.25	2.00
10.	Crushed stone, ¾″	Ton	2.50	2.25	2.50	2.25	1.30	.....	.....	2.75	5.25	.....
11.	Wire nails	Keg	5.00	5.00	.....	4.25	4.25	3.75	4.05	4.25	4.00	3.85
12.	Window glass, single A, 10″x12″	50 sq. ft.	.....	4.27	.....	4.20	4.20	4.00	.....	.....	.....	3.70
13.	Hollow tile, 8″x12″x12″	Each	.30	.30	.24	.21	.22	.24	.20	.18	.....	.23
14.	Cast iron soil pipe, 4″ E. H., 13 lbs. per ft	Ton	.....	.....	.....	61.75	63.05	62.50	.....	.....	.....	75.00
15.	Steel pipe, 1″ galv	100 ft.	.....	.....	.....	10.52	10.00	9.88	.....	11.81	9.46	9.97
16.	Reinforcement bars, ¾″ square	100 lbs.	.....	.....	.....	3.60	.....	3.50	3.85	4.60	5.00	3.75
17.	Structural steel, fab. 6″ I beams	100 lbs.	.....	.....	.....	4.50	3.65	3.75	4.50	5.50	5.00	3.90
18.	White lead, dry	100 lbs.	14.00	14.50	.....	12.60	14.00	.....	.....	14.75	14.00	12.50
19.	Zinc oxide, Am. process lead free	100 lbs.	.....	.....	.....	.....	.....	.....	.....	20.00	20.00	.....
20.	Gypsum plaster, neat	Ton	.....	26.00	.....	18.00	17.00	20.00	19.50	20.00	22.00	22.00
21.	Linseed oil, raw, in bbls	Gal.	1.08	1.35	.....	1.03	1.06	.96	1.12	1.15	1.35	1.01
22.	Roofing slate, No. 1 ribbon	100 sq. ft.	.....	.....	.....	15.00	.....	.....	.....	.....	.....	15.25
23.	Tar paper, roofing, 2-ply, 75 lbs. per roll of	100 sq. ft.	3.00	2.75	2.50	1.80	2.00	3.75	.....	.....	.....	3.50
24.	Rosin sized sheathing, 3-ply, 30 lbs. per roll of	500 sq. ft.	1.80	1.30	.....	1.50	1.50	1.45	.....	.....	1.00	1.35

	Erie, Pa.	Cleveland, Ohio	Dayton, Ohio	Detroit, Mich.	Bay City, Mich.	Milwaukee, Wis.	Waterloo, Iowa	Council Bluffs, Iowa	Des Moines, Iowa	Kansas City, Mo.	Grand Forks, N. D.	Sioux Falls, S. D.	Shreveport, La.	San Antonio, Tex.	Tucson, Ariz.	Seattle, Wash.	Portland, Ore.
1.	.....	$16.00	$18.00	$17.50	$16.00	$13.50	$16.50	$16.00	$19.00	$16.50	$13.50	$18.00	$15.00	$15.50	$15.00	$20.00	$20.00
2.	$ 3.40	3.48	3.40	3.72	.....	2.66	3.00	2.90	3.40	2.90	3.40	.....	3.20	3.60	4.10	3.00	3.00
3.	.....	56.00	55.00	45.00	50.00	48.00	52.00	50.00	52.00	49.00	.....	.....	46.00	57.00	.....	.....	.....
3a.	.....	.....	55.00	.....	.....	48.00	50.00	50.00	52.00	49.00	50.00	47.00	.....	.....	62.00	22.00	23.00
3b.	.....	.....	52.00	45.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4.	48.00	48.00	.....	45.00	48.00	45.00	46.00	48.00	60.00	55.00	48.00	47.00	50.00	66.00	60.00	22.50	24.00
5.	.....	98.00	90.00	.....	78.00	83.00	95.00	110.00	105.00	110.00	.....	.....	100.00	120.00	.....	.....	.....
5a.	.....	.....	.....	.....	.....	.....	95.00	97.00	95.00	90.00	95.00	85.00	.....	.....	100.00	65.00	55.00
6.	7.00	6.00	6.20	6.75	6.00	6.75	6.50	6.00	7.50	6.00	5.00	5.20	.....	6.80	.....	4.00	.....
6a.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.20	.....	7.00	.....	.....
6b.	6.50	6.25	6.50	7.00	5.75	6.50	7.50	7.25	6.20	5.75	.....	7.50	7.70	9.00	.....	.....	.....
7.	45.00	32.00	.....	30.00	37.50	42.00	36.00	35.00	46.80	32.50	60.00	32.00	45.00	58.00	.....	35.00	36.63
8.	22.00	18.00	16.00	20.00	18.00	.....	20.00	22.50	21.20	.....	.....	24.00	25.00	20.00	23.00	22.00	.....
9.	3.00	2.50	2.00	2.75	1.50	2.25	1.75	3.50	2.00	1.90	3.00	.....	2.25	1.25	.....	1.85	1.35
10.	3.00	3.50	2.00	2.35	3.50	2.67	3.50	5.00	4.50	2.25	.....	.....	4.32	3.50	.....	2.10	2.00
11.	3.65	.....	3.90	4.25	3.75	4.25	4.50	5.15	4.25	4.20	5.50	.....	4.60	6.20	6.25	4.35	4.35
12.	.....	.....	4.50	5.00	4.50	.....	5.25	.....	4.80	4.90	.....	.....	4.27	4.80	.....	4.50	5.13
13.	.24	.....	.21	.20	.13	.18	.17	.....	.....	.17	.....	.19	.22	.28	.18	.20	.20
14.	.....	.....	.....	.....	90.00	.....	82.00	.....	.....	73.44	.....	.....	106.26	116.00	.....	96.00	91.47
15.	.....	.....	10.57	.....	9.50	10.50	12.00	.....	11.25	11.20	.....	.....	11.95	11.12	14.00	14.20	12.78
16.	.....	.....	5.50	3.75	3.65	3.60	4.00	3.80	3.35	5.25	.....	.....	4.00	4.00	5.00	3.20	3.50
17.	.....	.....	3.50	6.00	3.60	4.50	4.95	4.10	5.00	4.70	.....	.....	6.50	4.50	.....	4.75	6.00
18.	.....	14.00	14.50	.....	14.50	14.00	14.50	12.80	14.50	14.13	.....	.....	15.00	15.00	15.25	11.75	13.25
19.	.....	.....	15.00	.....	18.00	.....	19.00	.....	14.75	14.13	.....	.....	.....	16.00	.....	19.00	.....
20.	24.00	.....	18.00	17.00	18.00	.....	18.00	18.00	18.00	18.00	27.00	20.00	24.00	20.00	21.00	21.00	20.00
21.	.....	1.12	1.20	.....	1.20	1.25	1.30	1.20	1.25	1.11	1.50	.....	1.35	1.30	1.40	1.25	1.27
22.	.....	.....	.....	.....	16.00	18.00	18.00	.....	18.00	17.00	.....	.....	12.00	18.00	.....	.....	.....
23.	.....	2.50	.....	1.90	2.65	2.75	3.25	3.80	2.65	.....	3.75	3.75	.....	3.50	2.90	.....	.....
24.	1.40	.90	.....	1.25	1.10	1.45	1.50	1.50	1.50	.....	2.00	1.50	1.40	2.25	1.75	1.25	.....

Pittsburgh Steel and Iron Prices

The following data on prices and freight rates are taken from The Iron Age of Oct. 11:

Plates, sheared, tank quality, base, per lb	2.50c
Beams, channels, etc., base, per lb	2.50c
Soft steel bars, base, per lb	2.40c
Reinforcing steel bars, base, per lb	2.40c
Track spikes, 9/16 in. and larger, base, per 100 lbs	$3.15
Track spikes, ½ in. and smaller base, per 100 lbs	3.15-3.50
Spikes, boat and barge, base, per 100 lbs	3.50
Track bolts, ¾-in. and larger, base, per 100 lbs	4.00-4.25
Tie plates, per 100 lbs	2.55-2.60
Angle bars, base, per 100 lbs	2.75
Butt welded steel pipe, ¾-in.—Percentage discount—Black 60; galv.	48½
Butt welded steel pipe, 1 to 3 in.—Percentage discount—Black 62; galv.	50½
Lap welded steel pipe, 2½ to 4 in.—Percentage discount—Black 57; galv.	46½
Pig iron, No. 2X, Philadelphia, per gross ton	$24.76
O.h. rails, heavy, at mill, per gross ton	43.00

Freight Rates

All rail freight rates from Pittsburgh on domestic shipments of finished iron and steel products, in carload lots, to points named, per 100 lbs., are as follows:

Philadelphia	$0.32	St. Louis	0.43
Baltimore	0.31	Kansas City (pipe)	$0.705
New York	0.34	St. Paul	0.60
Boston	0.365	Omaha	0.735
Buffalo	0.265	Omaha (pipe)	0.705
Cleveland	0.215	Denver	1.27
Cleveland, Youngstown, comb.	0.19	Denver (pipe)	1.215
Detroit	0.29	Pacific Coast	1.34
Cincinnati	0.29	Pac. Coast, ship plates	1.20
Indianapolis	0.31	Birmingham	0.58
Chicago	0.34	Memphis	0.56
		Jacksonville, rail and water	0.415

Index Numbers of Wholesale Prices

An "index number" is really a percentage, and in the case of an "index price" shows the relative price level at different times. In the accompanying table the price level, or "index price," is 100 for the year 1913; and the indexes for other periods are those calculated by the U. S. Department of Labor.

In previous issues it has been stated that the index of building materials did not include steel. This is in error, as the revised index is a weighted average of the principal building materials including steel and certain other metals. All figures given in this table are in accordance with the revised calculation.

	Farm products.	Foods.	Cloths and clothing.	Fuel and lighting.	Metal and metal products.	Building materials.	Chemicals and drugs.	House furnish'g g'ds.	Miscellaneous.	All commodities.
1913	100	100	100	100	100	100	100	100	100	100
1914	103	102	98	93	85	92	101	100	95	98
1915	104	105	98	88	99	94	134	100	95	101
January	104	106	94	87	82	88	108	99	99	98
July	104	104	96	81	106	94	130	100	94	100
October	106	102	101	94	105	98	151	100	93	102
1916	123	121	127	136	162	120	181	106	121	127
January	110	109	110	113	133	110	84	103	110	113
April	113	114	118	120	164	120	200	104	110	121
July	117	117	125	121	158	120	175	107	120	123
October	136	134	137	128	164	124	164	109	132	136
1917	190	167	175	169	231	157	202	126	148	177
January	152	149	158	171	198	138	173	118	149	153
April	184	164	164	164	230	155	186	121	153	173
July	196	169	181	176	292	168	205	129	153	188
October	207	180	185	153	207	156	231	137	142	183
1918	218	188	228	170	187	172	215	153	156	194
January	211	182	201	164	183	161	223	137	145	184
April	213	181	220	166	184	169	228	144	152	190
July	217	185	238	175	189	177	209	159	159	196
October	225	198	245	176	192	177	211	164	163	202
1919	231	207	253	181	162	201	169	184	175	206
January	224	203	220	178	175	176	181	167	166	199
April	230	205	205	177	153	169	160	167	160	195
July	241	210	262	181	160	209	167	183	177	212
October	227	205	291	189	162	229	173	194	187	211
1920	218	220	295	241	192	264	200	254	196	226
January	247	231	339	194	175	274	189	239	194	232
April	243	238	336	221	203	300	210	242	206	245
July	233	238	300	259	202	269	212	275	203	241
October	187	201	245	280	191	240	198	271	188	211
1921	124	144	180	199	129	165	136	195	128	147
January	143	162	196	247	153	192	153	217	154	170
April	117	144	176	205	138	167	135	216	130	148
May	118	139	173	200	138	165	134	209	126	145
June	114	137	172	191	133	163	133	196	125	142
July	119	141	172	186	124	160	129	180	123	141
August	123	146	171	184	117	156	129	179	119	142
September	124	142	178	181	116	156	131	179	118	141
October	124	140	180	189	116	159	131	180	118	142
November	121	139	180	197	114	163	129	178	119	141
December	120	136	180	199	113	158	127	178	121	140
1922	133	139	180	220	122	169	124	176	117	149
January	122	131	176	195	112	157	124	178	117	138
February	131	135	174	191	110	156	123	177	117	141
March	130	137	172	191	109	155	125	175	117	142
April	129	137	171	194	113	156	124	175	116	143
May	132	138	175	216	119	160	122	176	116	148
June	131	140	179	225	120	167	122	176	114	150
July	135	142	180	254	121	170	121	173	114	155
August	131	138	181	271	126	172	122	173	115	156
September	133	138	182	244	134	180	124	173	116	153
October	138	140	188	226	135	183	124	176	120	154
November	143	143	192	218	133	185	127	179	122	156
December	145	144	194	216	131	185	130	182	122	156
1923—										
January	143	141	196	218	133	188	131	184	124	156
February	142	141	199	212	139	192	132	184	126	157
March	143	143	201	206	149	198	135	185	127	159
April	141	144	205	200	154	204	136	187	126	159
May	139	144	201	190	152	202	134	187	125	156
June	138	142	198	186	148	194	131	187	123	153
July	135	141	198	183	145	190	128	187	121	151
August	139	142	193	178	145	186	127	183	120	150
September	144	147	202	176	144	182	128	188	121	154

Fundamentals of Cold Weather Concreting

Methods for Winter Work Described in Booklet of Portland Cement Association

Since warmth and moisture are required for the proper hardening of concrete, cold weather work should be planned with those necessities in view. Both the mixing water and the aggregates should be heated. The cement forms but a small portion of the concrete and need not be heated, but it is well to keep it in a warm place for a few hours before it is used.

Heating Materials.—The nearer the temperature of the water is to the boiling point the better will be the results because it will take longer to dissipate the heat and cool the mixture. There are several types of water heaters that can be used, but the most common method of heating is to pass steam into the water tank. The concrete should be mixed with the least amount of water practicable to produce a workable, plastic mixture. An excess of water must be carefully avoided.

Many methods are used for heating aggregates. A simple method is to use a length of iron pipe, an old boiler, or any metal cylinder over which the sand, broken stone, or pebbles can be piled, and in which a fire can be built. Care must be taken to heat the fine and coarse aggregates separately in order to avoid pre-mixing them in wrong proportions. As this method entails rehandling the aggregate, and as the aggregates nearest the heater may be affected by excessive heat, the use of steam pipes is generally proferred.

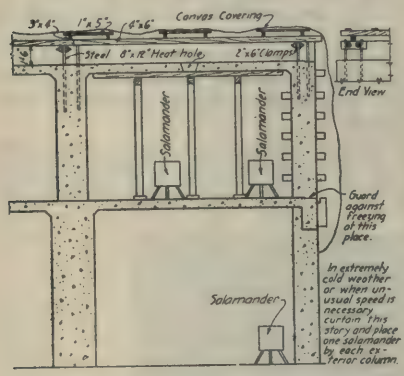
Steam heating is a more expensive method and requires a steam boiler, but on large jobs this method is usually advantageous because the steam may also be used for other purposes. A practical method is to use a perforated steam pipe with a pointed end which can be worked into the piles of aggregates. To reduce loss of heat the piles of aggregates should be covered with tarpaulins.

Method Inclosing Keenan Hotel at Fort Wayne, Ind.
The 14-Story Reinforced Concrete Structural Frame Was Built in the Winter of 1922-1923, at the Rate of One Story in Less Than One Week. By Keeping Five Stories Inclosed at One Time the Newly Placed Concrete Was Kept Warm for About Four Weeks.

If the materials are heated as above outlined, and the concrete is deposited immediately after mixing, its temperature when placed in the forms will be around 80° F. and if care is taken to prevent too rapid loss of this contained heat, the concrete will harden properly. The early stages of harden-

ing may be even more rapid than under ordinary conditions.

Heating the Forms.—The forms must be free from snow, ice and frost, and should also, if possible, be reasonably warm, especially in the case of metal forms, which will absorb heat from the concrete rapidly. Live steam is an effective agent for cleaning ice



Cross-section of Building Under Construction During Winter Weather and Showing the Placing of Salamanders and Canvas Covering.

and snow from the forms, and warming them. It should be used just before the concrete is placed.

Protection and Supplying Heat While Hardening.—A rapid loss of contained heat must be prevented. Protect the concrete while hardening so as to maintain the warm, moist condition essential for the rapid development of strength. There are many methods of doing this: the most common is an enclosure of canvas or tarpaulins. In mild weather this alone may be sufficient, but when the temperature drops below the freezing point, some means should be provided for heating the enclosure. Steam escaping from perforated steam pipes around the concrete will give the best results, because the steam saturates the air and prevents evaporation of moisture from the concrete.

Coke salamanders or stoves are often used when steam is not available to supply warmth to the enclosure, but large pans of water should be placed over them in order to provide as much moisture in the air as possible. Care should be taken not to have these stoves or salamanders so close to the concrete as to dry it out in spots. An even temperature of at least 60° F. should be maintained at all times in all parts of the enclosure. To maintain this temperature within a properly housed enclosure during cold weather, with good coke properly handled, one salamander will be required for every 300 to 500 sq. ft. of floor area.

The most common practice is to build inclosures of tarpaulins, overlapped so as to prevent rapid escape of heat, about two stories being inclosed at one time. Undoubtedly a better method was the one followed in the winter of 1922-1923 in the construction of the Keenan Hotel, a 14-story reinforced concrete building in Fort Wayne, Ind. As shown in the illustration, five stories were inclosed at one time. This prolonged the length of time during which freshly placed concrete was kept warm and

Canvas Envelope Protection for Concrete Chimney. Interior Was Kept Warm by Salamander at Base of Chimney.

resulted in complete hardening before the protection was removed.

A more substantial form of protection is the complete wooden inclosure shown in our illustration of the Robertson-Cataract Electric Company

building. The Majestic Building in Milwaukee, as the illustration shows, was built under a complete inclosure of tarpaulins supported on framework. Complete inclosures necessarily cost more than temporary ones that protect only a few stories at a time.

Protection for Bridge Constructed at Waterloo, Ia., During Winter of 1921. Arch Ring and Hand Rail Are Protected by Use of Manure.

Their great advantage, however, consists in the fact that they protect the workmen of all trades and speed up the work from beginning to end. Furthermore, when once built they require no shifting.

The complete inclosure idea was

Protection for 48-Apartment Building in Milwaukee.

followed in the construction of the three-span reinforced concrete arch bridge over the Little Goose River, in Wyoming. A large tent covered the entire bridge site and permitted construction during severe winter weather when the stream was solidly frozen over. The cold weather, in fact, eliminated trouble from running water and actually speeded up the progress of the work. Fires were kept going in stoves with smoke outlets extending through the top of the tent. During the placing of concrete a heavy snow storm, followed by severe cold that lasted several days, tested the effectiveness of the tent. The protection proved equal to the emergency.

For retaining walls and similar structures a light roofing paper envelope placed outside the forms with steam pipes at the bottom has proved satisfactory.

Protective Coverings.—When it is warm during the day with a temperature drop close to the freezing point at night, floors, pavements and foundations are often protected by cover-

ing with straw, hay or other material with satisfactory results, but such covering should not be relied upon during protracted low temperature.

Even though the outdoor temperature may not drop to freezing, protection is necessary to prevent the concrete from losing the heat introduced by heating the materials, and insure proper hardening. At low temperatures the heat developed by the chemical reaction of the cement and water is too small to be safely relied upon except in large masses underground. Even in those cases the materials should be heated and the surface protected.

Thin structural members and floors have such a large surface area in proportion to their size that the heat within the concrete is dissipated rapidly, and therefore protection must be provided. Recent inspection of several concrete floors placed during the winter of 1922-1923 disclosed the fact that the top surface was inadequately protected after being placed. On one floor in particular it is known that the top surface was placed during cold weather and no protection whatever was provided. It was permitted to freeze almost immediately after it was placed, and it is probable that it froze and thawed several times before it hardened. The result was an unsatisfactory wearing course which in many places must be removed and replaced. Work of this kind should be protected with canvas, supported slightly above the surface, and with live steam forced under the canvas. The steam has the excellent characteristic of providing both heat and moisture, both essential in obtaining the best results in the hardening of concrete.

Use of Salt or Calcium Chloride.—The practice of adding "anti-freezing" compounds such as sodium chloride (common salt) or calcium chloride solutions to the concrete mixture is not generally recommended. Under no circumstances should they be depended upon to prevent freezing below 22° F., and they should never be considered substitutes for protection and heating.

Complete Inclosure of Robertson-Cataract Electric Building, Milwaukee.

Calcium chloride in quantity not exceeding 4 per cent, by weight, of the mixing water is a better anti-freezing agent than common salt. It accelerates the hardening of concrete to some extent, while salt retards hardening. Salt has a tendency to corrode reinforcing steel, and may cause efflorescence, which is unsightly on exposed surfaces.

Even if anti-freezing solutions are used, the aggregates and mixing water should be heated to remove ice or frost.

Application of Load.—Too early removal of forms is always to be guarded against even during construction in favorable weather, and great caution should be observed in placing loads upon cold weather concrete. Especially is this true of walls, roofs and floors above ground, which carry loads other than their own weight.

Before removing forms the concrete should be examined to see that it has properly hardened and not frozen. A reliable test is to apply heat to the surface by means of a blow torch or a jet of hot water or steam against it. Frozen concrete will be disclosed by softening as it thaws out, but if properly hardened, the concrete will be unaffected by the application of heat.

Complete Inclosure for Addition to Majestic Building, Milwaukee. View Taken in February, 1923.

Removal of Collapse in Western Red Cedar Shingles

The development at the U. S. Forest Products Laboratory of a kiln treatment by which collapsed or badly crimped shingles of coastal grown western red cedar can be restored to a usable condition indicates that the salvaging of both collapsed singles and boards of this species may be commercially feasible.

It was found that the crimp which occurs in drying excessively wet wood of western red cedar and a number of other woods is due to a collapse of the wood cells caused by removal of the free water with which they are filled. The wood may be redried without collapse if the cells are restored to their former shape by remoistening without pemitting them to fill with water again. This treatment can be accomplished with loose shingles in 2 days, but it is less practicable to do it in the bundle on account of the long time required.

The treatment in general is as follows. The shingles are laid flat in the kiln on suitable racks in separate layers. Live steam is injected at boiler pressure through perforated pipes to produce a high circulation, and the air is held in a saturated condition at 180° F. for 20 hours, after which the temperature is increased to 190 or 200° for 3 or 4 hours. Following this the free steam is shut off, the heating coils are turned on, and the shingles are dried at a temperature of 160° and 35 to 25 per cent humidity. Less than 24 hours should suffice for thorough drying. Because of the need for a positive circulation in drying, either a water-spray or a blower kiln is desirable.

Occasional shingles fail to respond to the treatment, when the fibers have become crushed beyond recovery.

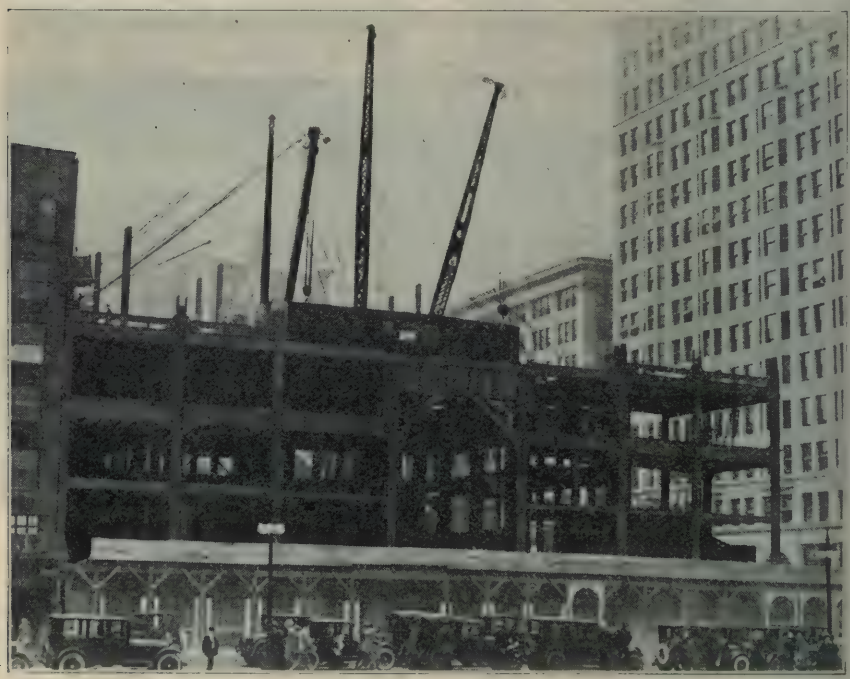
Although tests with a nail $\frac{3}{16}$-in. in diameter showed a slight increase in brittleness in the restored shingles, this defect was not evident when shingle nails were driven.

Placing a 68-Ton Girder

Putting one of the 68 ton (67.85 ton exact) girders, one of the three largest ever used in building construction in Chicago, in place on the fifth floor of The Straus Building on Michigan Ave. at Jackson Blvd., was accomplished in record time. The girder, 55 ft. long and standing 11½ ft. high, was raised 50 ft. and set into place in five minutes. The load was divided evenly between one of the regular derricks, 123 ft. high with a boom 110 ft. long and a special gin pole made of 20 in. square Norway pine timber, 50 ft. in length. Two 100 h.p. hoists furnished the power, together with an extremely simple rigging.

The special gin pole rigging consisted of a set of four sheave blocks rove up with wire cable so that the gin pole could be boomed up the same as the regular derrick, carrying the other half of the load. Six ordinary 1½ in. lines rove up in 16 in. wood blocks were used as guy lines on the gin pole.

This girder and another of like size not only carry their share of the load of the 22 story main shaft of the building but also the center load of the 10 story tower structure.



Placing 68 Ton Girder in 5th Floor of Straus Building, Chicago.

Tests of Hollow Tile Walls

The U. S. Bureau of Standards has just published the results of 32 tests on walls of hollow tile. These walls were 4 ft. long by 12 ft. high, and were 6, 8 and 12 in. thick, representing the outer wall of a house. Among other results, these tests showed that a wall with the hollow spaces or cells of the tile set vertically is nearly twice as strong as one in which the cells are placed horizontally. These tests are described and the results given in Technologic Paper No. 238 of the Bureau of Standards, entitled "Some Tests of Hollow Tile Walls." Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. The price is 5 ct. cash.

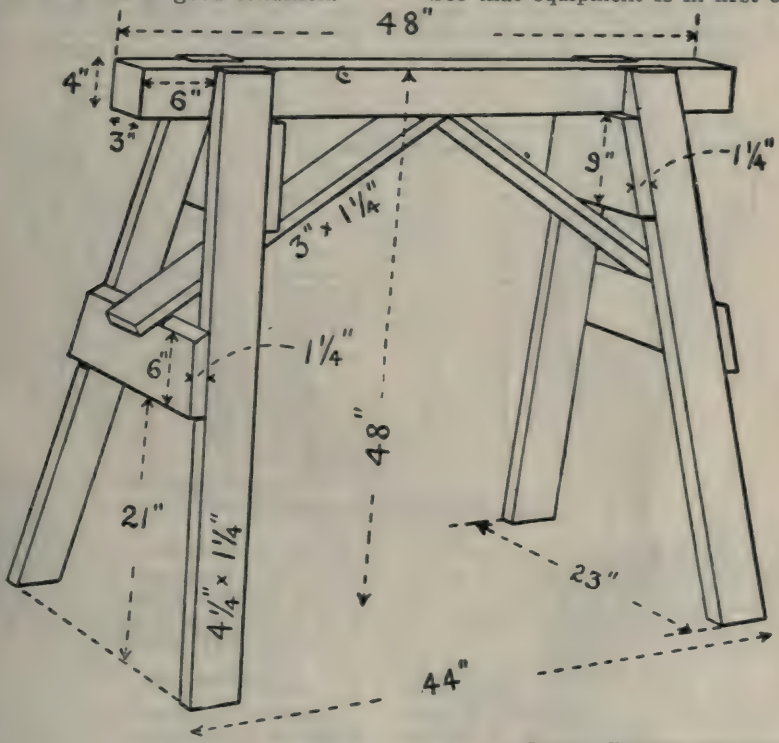
Safe Practices on Construction Work

Extracts from a Pamphlet Prepared by the National Safety Council. The Complete Pamphlet Will Be an Appendix to the Safety Code for Construction Work Now in Process of Formation Under the General Auspices of the American Engineering Standards Committee and the Direct Sponsorship of the National Safety Council.

Superintendents and foremen should feel their responsibility for preventing accidents. It is their duty to see that tools, equipment, and materials used are in good condition.

Instruct your men to report all accidents no matter how trivial. Minor injuries neglected produce most of the infection cases.

See that equipment is in first class



Courtesy Travelers Insurance Co.

A Well-Designed Horse.

Use judgment in assigning men to do certain work and be sure they are capable.

Call attention of men to any dangerous conditions so they can be on lookout.

Post conspicuous signs warning the public to keep out.

Post danger signs where necessary. Station watchmen where necessary.

See that accident reports are properly filled out.

working condition before being sent from yard to job, or from one job to another. Inspect frequently while on job. Have all gears, belts, and other moving parts well guarded.

Wrecking.

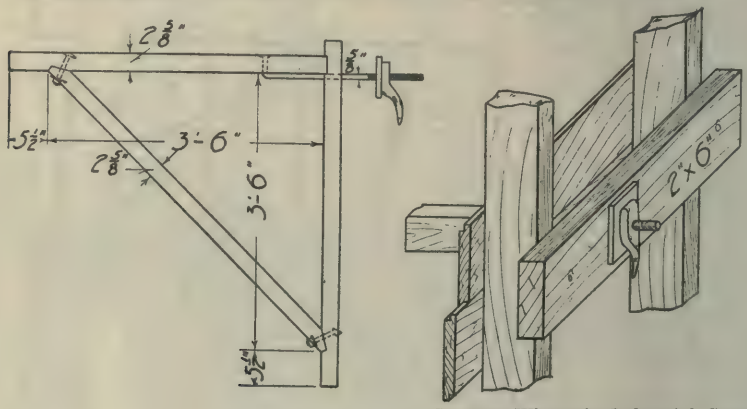
Erect overhead protection sheds, guardrails, and fences to protect the public and workmen, with warning signs for public. Place red lights at night. See that all gas, electricity and water are shut off from the build-

ing. Remove glazed sash from windows at the start of operations. Use enclosed chutes to convey material from upper floors, with baffles if run exceeds two floors, and heavy weighted canvas at mouth to prevent material bounding out of trucks. Danger sign should be placed at the discharge end of every chute.

Timbers, steel beams and other heavy or bulky material should be lowered—not thrown. If necessary to throw material out of building post watchmen. Never allow sections of walls to fall in mass on floors. Remove walls part by part; if thin or weak, erect staging for men to work on. Chimneys and walls generally should not be pulled down as a whole. Walls and chimneys should not be left in such condition that they may be overturned by wind, built-in beams, or other force.

Do not allow material to accumulate on a floor so as to overload it. Scaffolds used on walls should be self-supporting, especially on a burned building. Exercise special care in cases where beams are embedded in party walls. Do not allow boards having nails in them to accumulate on floors or ground. Heavy soled shoes should be worn, to guard against injury from nails. Heavy gloves are a great protection from nails, slivers, and bruises. Avoid eye injuries from flying pieces, dirt, and dust, by wearing goggles. Place screens to prevent flying pieces from injuring fellow workmen. Use water to reduce dust when tearing down plaster or brickwork. Have no unnecessary work going on below; protect men removing material.

Use of Oxy-acetylene Cutting Flame.—The use of acetylene flame for cutting steel beams should be in the hands of an experienced man who understands the process. Avoid cutting off important members which support parts of building still standing. Beams to be cut should first be properly secured by cables or chains. Avoid being caught in the swing of the beam after it is cut off. Require operators to wear goggles with special colored glass conforming to U. S. Bureau of Standards Goggle Code. Acetylene gas is poisonous even when diluted with air; take care not to inhale it. Permit no combustible material near acetylene torch. Handle oxygen tanks with care; do not drop them, nor expose to direct rays of sun nor to any high temperature.



Courtesy Wisconsin Industrial Commission

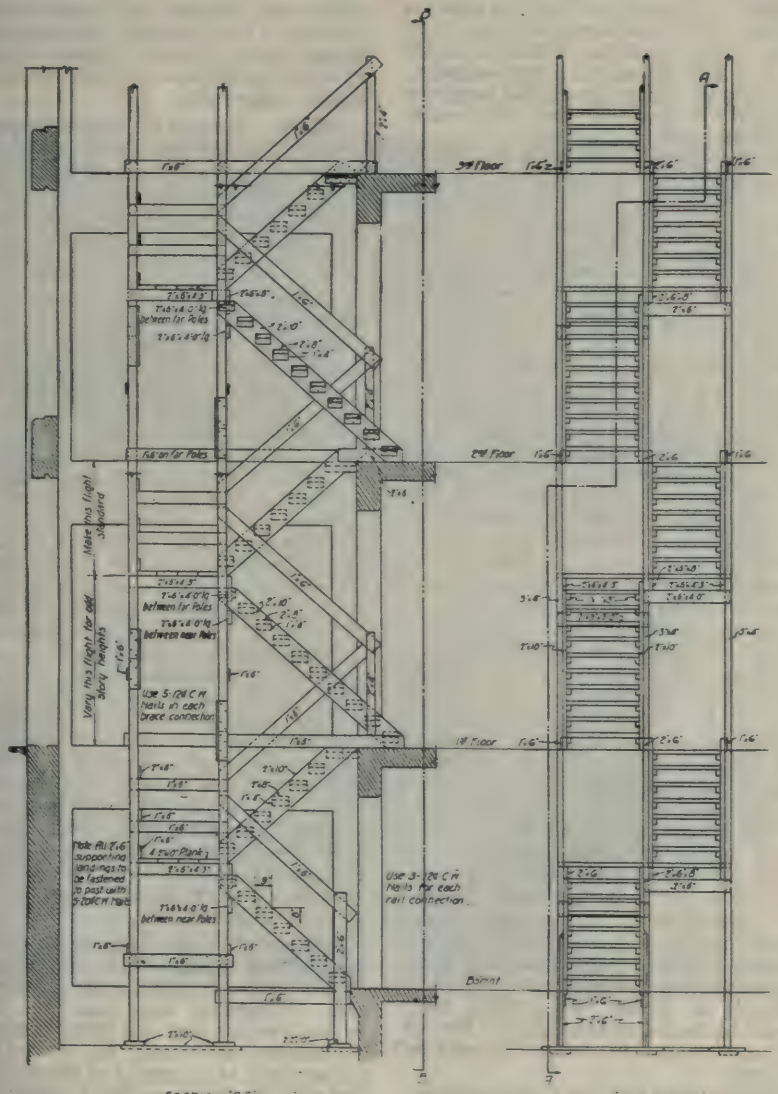
A Safe Bracket for Carpenters' Scaffold.

Hoists and Derricks

Towers.—Construct towers of sound material, and ample strength for the loads intended. Use only experienced men in the erection and taking down of towers. Towers and all parts thereof should be regularly and frequently inspected. Important members of towers should be bolted rather than spiked or lashed. A substantial ladder, securely fastened, should extend the entire height of tower. Provide substantial platform with railing and toe board at each working level. See that towers are properly guyed and well anchored. Do not attach guys to freshly poured concrete or other insecure parts of new work. There

should be a set of guys every 40 ft. In building tower, provide temporary guy lines near top of second length of uprights. In public streets keep guys high enough to clear persons and trucks. Bottom of tower should be screened or planked in on as many sides as possible. If tower is close to occupied building, screen should run entire height of tower on building side, and all openings to floors should be specially protected.

Platform Elevators.—Post danger signs on elevators forbidding anyone to ride, and strictly enforce this rule. Engineers who allow riding must be discharged. Platform of elevator should be strongly built, with toe-boards on unused sides, and roof of 2 in. plank. Platform should be of



Courtesy Aberthaw Co.

Typical Good Construction of Temporary Stair Tower.

sufficient size so wheelbarrow handles will not project over the edge; nail stop cleats on platform for wheelbarrow. If elevator is located inside the building the opening at each floor should be guarded with bar gate or railing. It is best to place these 2 ft. away from opening. Where elevator runs to the basement only occasionally, special attention should be given to guards to prevent men from walking underneath.

Bucket Hoists.—The pit should be well drained and arranged so that any spill will fall below the blocking in which the bucket rests while being filled. Never allow men in the pit to work without first resting the bucket on timbers placed across opening and resting on solid supports on two sides of the pit.

Engineer.—Engineer should be notified before men go up ladder, or before any work is done on any part of the hoist, machinery, or in the pit. In changing shifts engineer should advise next operator as to any defect. During winter months housing should be erected to protect engineers from the cold—an engineer with numb hands cannot properly control his throttle and brakes. Exhaust steam pipes should discharge so as not to obstruct engineer's view. Where the hoist engine is placed close to the building the engineer and helpers should be protected against falling material by 2 in. plank roof.

Hoist Engine.—Inspect frequently and take special care to see that brakes, operating levers, and gears are in proper working condition. Do not let oil get on brake drums. Exposed gears should be guarded. A dog or pawl should be used to hold the load when it is to be suspended for any considerable time; the brake should not be depended upon for this purpose. Steam pipes running from engine to other machinery should be covered; if placed on ground they should be boxed or fenced off. Do not set hoist engine in street if it can be avoided.

Signals.—Whistle signals for hoisting are dangerous; they may be confused with other noises. Hand signals are satisfactory where the engineer can always see the signal man. A bell at engine, operated by pulling a wire is satisfactory; use only wire of ample strength, protected against fouling by guarding or enclosing in a pipe where exposed. Electric bells may sometimes be used to advantage. It is advisable to mark the cable to indicate the position of hoist at every landing.

Electric Motors.—Let only experienced men operate or repair electric motors. Care must be taken to avoid shocks and burns. Use enclosed switches and fuses and have switchboards railed off.

Cables.—Inspect all cables frequently and replace any that are worn, frayed, or partially broken. When cable is received in a coil it should be rolled out on the ground like a hoop and straightened out before it is put on the sheaves. If cable is received on a reel the reel should be mounted on a spindle or turntable and the cable properly unwound. Kinking and untwisting of the cable should be carefully avoided. All cables should be treated with a proper lubricant free from acid or alkali to penetrate and lubricate the inner wires and prevent rust. Prepared compounds furnished by cable manufacturers and dealers are best. Fasten cable to drum by zinc plugs or suitable clamps, and leave at least two full turns of cable on drum at all times. Cable should be wound evenly on drum; a guide pulley is advisable. Cables should be guarded at all points where persons or material might come in contact with them, such as: cables from engine to hoist; all horizontal cables less than ten feet above floor; cables over stairways, over or through passageways and near ladderways. Prevent chafing where cables run through floors, or against steel work and other objects. In attaching cable clamps have the U over the short end of cable. Tighten up nuts several times during operation under load. Use thimbles at bend of cable.

Ropes.—Use best rope only in hoisting. Rope deteriorates very quickly if not properly dried out after wetting. Whenever rope has been used or has become wet and dirty it should be cleaned and hung up, or laid in a loose coil so it may dry thoroughly. Do not throw down in a corner or cover with other material so air cannot circulate through coils. Alternate wetting and drying is more harmful than being always wet. Rope should not be allowed to freeze when wet, as frozen rope usually breaks.

Frozen rope should not be piled against steam pipes nor close to other sources of heat which will tend to

dry out the oil and thus destroy the life of the fibre. Avoid kinking, as this is one of the main causes of injury to manila rope; kinking is more liable to occur when the rope is wet. To prevent kinks in new rope while uncoiling, lay the coil on the floor with the inside end down; then reach down through the center of the coil and uncoil from the inside—never from the outside. Rope should not be dragged along the ground, over a rough surface or cross itself. Avoid sharp bends of rope over an unyielding surface. Do not make a rope fast on sharp objects or surfaces. Rope should not be stored in the same place with acid containers, nor used in locations where exposed to acid. When cleaning down buildings from scaffolds, avoid acid by keeping fall line on outside of scaffold, with free end coiled in a box or barrel several feet away from building so rope slopes away from building. If necessary, the portion of the rope just above scaffold may be protected by a canvas shield or sleeve.

Chains.—Chains should be inspected frequently and with care. Watch for small cracks. Chains are less reliable than rope or cable, as they break without warning. "Crystallization" is merely an excuse for breaking of chains under shock or repeated stress. The remedy is to avoid shock and overloading. Proper heat treatment is beneficial but it cannot be given satisfactorily in an ordinary shop. If attempted there, it may result in in-

Courtesy Travelers Insurance Co.

Derrick Foot, Well Braced.

jury rather than benefit. Do not let the chain kink. Chains break by kinks straightening out and dropping the load a short distance.

Hooks.—Be sure that each hook is correctly designed to lift the load without overstraining. Forged steel hooks are preferable for use in every case. Hooks which have become bent should not be used. Do not put too many parts of lashing into a hook, as this may open up the hook. Use hooks that close, if there is danger of catching an obstruction. Use care so that fingers or hands will not be caught between hook and load.

Sheaves.—Use sheaves of largest practical diameter; inspect frequently and keep well oiled. Test cast-iron sheaves and pulleys with a hammer to detect cracks. Sheaves that have become worn should not be used, as they injure the cable. Carefully line up sheaves and drums to avoid wear on sides and on cable. Blocks designed for manila rope should not be used for cable because the cable does not fit the grooves in the sheave. Blocks should be well anchored, and guarded if near floor or otherwise exposed.

Derricks.—See that derrick is strong enough for loads to be lifted; on good foundation, securely anchored and braced. Inspect frequently. The top of the mast should be securely held in place by no less than six guy wires. Secure the guys to guy plates by means of shackles. When work is stopped for any length of time, lower boom to horizontal or raise to vertical, to prevent swinging in the wind or being meddled with. Special care should be taken if boom is longer than mast, and in vertical position, to avoid pulling off top goose-neck or spider. Do not depend on cotter pins to hold the goose-neck or spider in place but see that strong holding down guys are installed. Always use double sets of bolts to fasten back legs of stiff leg derrick. Always enclose stiff-leg derrick weights in well constructed boxes. Inspect and oil sheave and pulley pins. Oil gudgeon pin and foot bearing. Use a shackle instead of a hoisting hook with swinging buckets. Bucket may strike an obstruction and be lifted off an ordinary hook. Always keep hooks closed. See that only experienced men make the sling hitches on loads. Slings should be frequently inspected and not left lying on the ground. A hold-back line or guide rope should be used on all loads that are liable to swing. Do not allow workmen to ride on loads handled by derricks or on chain slings.

Breast Derricks.—Gears should be thoroughly protected. Provide ratchet stop to hold load. If load is lowered by hand cranks take care that cranks do not come off unexpectedly. The safest way is to drill hole and place cotter pin through each end of shaft. Mechanical brakes, however, should be provided and operator must be sure that brakes will hold. Before lowering load, remove cranks to prevent striking someone. Provide front guy or other means to prevent falling backward. Breast derricks should be set on heavy planks.

Slings.—Slings should be provided as a part of the hoisting equipment, in charge of an experienced man, who should see that they are kept in good condition. Chain slings are dangerous and should be handled carefully by experienced men. Wire cable slings are better than chains or fibre rope. They must be inspected and oiled. An endless cable makes a convenient sling. Ends of rope or cable slings should be properly spliced to form the loops, and loops should be lined with a properly formed sheet metal thimble to withstand wear. Do not let slings lie around on the ground or on floors. On sharp corners use rounded block or heavy bagging to protect the sling. When using a multiple rope sling or a sling with both ends engaged in the hoisting hook, the sling should be adjusted so as to equalize the stress as well as possible.

Concreting

Spouting.—Build tripods strong and workmanlike. Spouting should be well guyed so it can not be blown by wind or fall on men. Always flush out spouting at the end of each run of concrete.

Hoppers. — Hoppers should have railed platform for men and protection below to catch spill. Opening gates should be controlled from above or from the side.

Runways.—Runways should be solidly built with smooth surface of ample width. Inclined runways should not be so steep that men will slip. Where runways are over 12 ft. from ground they should be railed.

Mixer.—See that all gears of mixers are properly guaded. If an elevating charging hopper is used, operator must see that men are out of

danger before hopper is lowered. Keep mixers clean and do not let waste material accumulate around mixer.

Concrete Buggies.—See that handle of buggies does not extend beyond wheels on either side.

Wheel Barrows.—Do not use wheelbarrows with split handles. See that wheels are strong, true running, and well secured onto the frame. Do not let men run with a wheelbarrow with the handles in an upright position. Nail stop cleats on platform of hoist so that handles will not project over edge.

Forms.—Protruding nails are the chief source of accidents on form work and sometimes result in serious infection and loss of members. Insist that workmen report all nail accidents, even the merest scratch. Heavy soled shoes are a protection. Flying nails are another source of many accidents. See that men use hammers with faces in good condition. Hammers with corrugated faces are recommended. Use mud sills under all shoring that rests on the ground. See that shores are properly braced. While concreting have one or more carpenters watching falsework. Workmen in sawing should not let ends of lumber drop on floor below. Workmen should be careful with tools and not permit hammers, bars, etc., to drop. Avoid having ends of loose plank, boards, etc., project over edge of floors or beams, as a workman is liable to fall if he steps on the end. When old lumber is used it should be cleaned and all nails removed before being sent to job. Do not bend over, or hammer in nails. Require use of guards on circular saws.

Stripping. — Before stripping a panel, place shores and ledgers to support it. Forms should not be removed permaturely. Be sure concrete is properly set—not frozen. Stripped lumber should be cleaned and nails removed; do not let old material lie around.

Masonry

Brick Work.—Brick basement walls should be braced sufficiently to withstand any load which may be placed upon them during construction. Do not backfill against green walls. Do not allow any load on walls causing vibration before wall has properly set. High walls require good bracing to withstand wind and other pressure. Guard against overloading of floors with material. Keep material well back from outside edges of open floors and all floor openings. When working above stair wells, near edges of floors, or near inside openings, bricklayers should be cautioned about slipping brick, or dropping pieces over the edge. See that scaffold horses are well made from good material, well braced, and resting on firm foundation—not on piles of brick or tile. Do not put guys or other stays through brickwork until it has firmly set, and then only in places that will safely withstand stress.

Provide goggles for men cutting brick or stone. If other men or the public are exposed, provide suitable screens.

Stonework.—Proper tackle is of great importance. Derrick operators should be experienced men. Stone should have proper holes to insure against slipping. See that proper type and sufficient number of permanent anchors are used so that stone cannot loosen during storms, during or after construction. In landing stone handled by a derrick operated by an engine care must be taken to prevent stone from damaging scaffold and injuring men. See that stone tongs and

Correct Position and Number of Forged Steel Clips for Fastening ⅝-in. Plow Steel Cable.

Four clips, spaced apart a distance equal to six diameters of the cable, with U-bolts all in contact with short end of cable. If applied properly—neither loose nor too tight—and kept that way by frequent inspection, tightening from time to time as the cable shrinks, these clips will give an efficiency of 75 to 80 percent. Large cables require more clips; small cables require fewer.

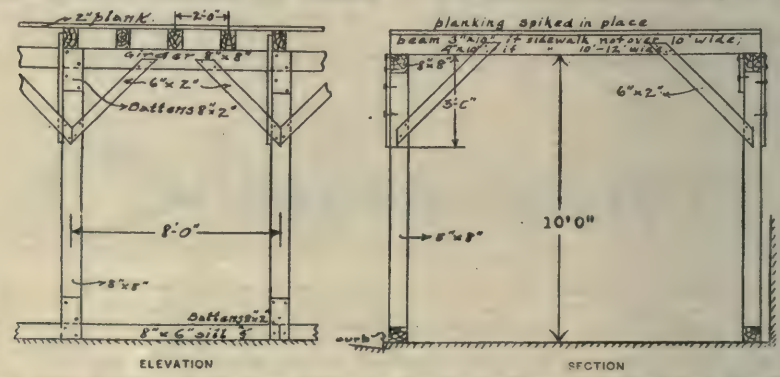
grab hooks are in good condition and strong enough for load.

Scaffolding, Railings, Etc.

Scaffolds, General.—All scaffolds must be inspected frequently. They must be built of sound lumber of selected structural grade, free from large knots and other imperfections. All plank for scaffold platforms should be carefully inspected and selected. Scaffolds should be erected and taken down by experienced men only. Nails should be pulled from the lumber as soon as scaffold is taken down. Do not use scaffolding built by others until after careful inspection. Do not overload scaffolds. Allow no one to remove timber or cut away supports or braces from scaffolds or staging without permission of the superintendent. If work is being carried on above men working on scaffold, all types of scaffolds should have overhead protection of roof of light lumber, heavy canvas, or heavy wire screen. Do not allow men to throw anything from the scaffold. Do not allow men to jump on a scaffold, nor allow material to be dropped on it. Men should not work on a scaffold during storm or high wind. Clean scaffolds daily of all rubbish, and do not allow tools, buckets, etc., to be left on scaffold when workmen leave. In winter remove snow and ice from scaffolds before starting work. Sprinkle platform with sand or other material to prevent slipping. Provide safe means of access by stairs or permanent ladder. If ladder is used see that it is in good condition, with upper end fastened so it cannot tip or slip. Protect scaffold against injury from trucks or wagons striking or dumping material against it. When hoisting do not let loads swing against or catch on scaffold. When possible avoid having men work under scaffolds.

Built-up Scaffolds.—There are two main types of built-up scaffolding, the single pole type in which one end of putlog rests on the wall and the independent pole scaffold. The latter type is much superior to the former and should be used instead of single pole type in all cases, if possible. See that the uprights rest on solid foundation so there is no danger of settling. Uprights must be plumb, and fixed at the bottom so they cannot shift.

For scaffolds not exceeding 50 ft. in height uprights should be 4x4 for mason's scaffolds and 3x4 for painters' and plasterers' scaffolds. When necessary to splice uprights, cleats not less than four feet long should be well nailed on two adjacent sides of uprights at the joints. Joints should be staggered. "Ledgers" or horizontal longitudinal ties should be not less than 2x6 or equal, well nailed to uprights. Crossbars or putlogs to carry platform should be not less than 2x8 or 4x4, well nailed either to the "ledger" close to the upright or to the upright itself. Longitudinal braces should be not less than 1x6, regularly placed and well nailed. Braces should extend from the foot of every third upright at 45 degrees in each direction. Splices of braces should come at the uprights if possible. Where not possible the overlay should be 30 in. or more and well nailed. Crossbraces in one direction should be put in between each pair of uprights. If win-



Good Type of Sidewalk Shed or Bridge as Required in Borough of Manhattan, New York City.

dow braces are used see that window frame is fastened securely in wall. It is better to let brace pass through window and be secured at floor. Platform plank should be laid tightly together and be not less than 2x9. They should be placed so that they cannot tip under weight of a workman, and should overlap at least 12 in. at each end. Platforms should be at least 4 ft. wide between uprights. In raising platforms to higher levels, pecautions should be taken to protect men below from falling dust and refuse. Erect guardrails on outer side of scaffolds of 2x4 material, 34 in. in height above the platform, well nailed to the uprights. Scaffolds above the fifth floor should have railing filled in with heavy wire netting or boards.

Toe-boards at least 9 in. high should fit closely to the outer edge of the platform to prevent tools, brick, and other material from falling off.

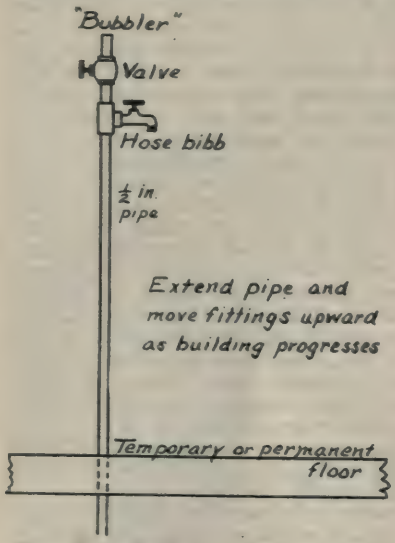
Outrigger Scaffolds. — Outrigger scaffolds for cornice and other light work are not favored if another type can be used. If used they should be carefully inspected by superintendent. Outriggers should be not less than 3x10. They should not project more than 6 ft. beyond face of building.

Swinging Scaffolds.—Hooks, anchors, and outriggers for swinging scaffolds must be well secured. If timber needle beams are used see that they are strong enough to carry the load. Swinging scaffolds should be lowered to ground or lashed to building when men leave. Every swinging scaffold for painting, etc., should have a guard rail. Do not allow men to hang tools on any part of the scaffold. When brickwork is being cleaned down with acid, ropes should be inspected at least daily. When scaffold is taken down ropes should be tied and tagged to indicate where they were used and they should not be used again without first being carefully inspected and tested. Do not allow ropes to be brought over or rub against sharp corners.

Suspended Scaffolds.—See that the outriggers are well secured to the frame by clamps or U-bolts. See that threads of the bolts are in good condition and that the nuts fit. See that shackles or beam clamps holding the cable are well fastened to the outriggers. A stop should be placed at the outer end of the outrigger. Only experienced men should be used on the winches to raise or lower the scaffold, and great care should be used to keep the platform level. It is very important on suspended scaffolds to have the guard rails, toe-boards, overhead roof and other protection in good condition. All moving parts of suspended scaffolds should be inspected daily and to enable this constant inspection to be made it is desirable that all working parts be simple in design and plainly in view of men on scaffold at all times.

Structural Steel.—Use care in passing material onto the platform and do not overload. Keep working floor solidly planked over. Also see local ordinance.

Horse Scaffolds.—Horses should be well made of good material and well



Home Made Bubbler for Construction Job.

braced, and of uniform height. Special attention should be given to see that each horse stands squarely on all four legs so that there is no "wobbling." They should rest on a solid foundation, not on piles of brick, tile, etc.

Pipe Scaffolds.—Pipe beams should be of new, common pipe, painted, and kept free from scale. No couplings should be used. Not less than 3½ in. pipe should be used where the scaffold is not over 6 ft. wide by 12 ft. span; for greater spans use larger pipes. There should be a hanger for pipe beams every 8 ft. See that the supporting ropes are so fastened to pipe that they will not slip off the ends. Bolts through holes in pipe,

near end, are desirable. Holes should be bored not less than 6 in. from end of the plank and ⅝-in. bolt 8 in. long placed through these holes to prevent plank slipping off.

Temporary Scaffolds.—Light temporary scaffolds built up to make repairs, etc., should not be made in a make-shift manner. Many accidents occur on temporary scaffolds, and they should be strongly built of good material. Temporary scaffolds should be removed as soon as work is completed.

Ladders.—For long-continued use, temporary stairways are more economical and safer than ladders. They should be substantially built, with railing wide enough for two men. Where ladders are used they should be substantially built set level, and well secured. The side rails should be of selected straight grained lumber free from knots larger than ½-in. in diameter. The rungs should preferably be of oak, ash, or hickory and should be inserted in holes in the side rails and securely fastened with a uniform distance between rungs. When it is necessary to use cross cleats instead of rungs the cleats should be housed into rails ½ in. If ladders are used as common passageway, provide one to go up and one down. Rails of ladders should always project at least 3 ft. above floor level. Do not paint ladders, as painting covers up defects—use linseed oil. Portable ladders should have non-slipping bases, or be so fastened at the bottom that there is no danger of slipping. Defective ladders should be destroyed. Substantial ladders should be destroyed. Substantial railings must be erected around all floor openings.

Floor and Wall Openings.—Doorways and passageways used by workmen should be protected from overhead dangers by the erection of suitable coverings. Erect barricades at all driveways and other outside openings to keep the public out. Openings in walls to elevator shafts, stairways, and in outside walls of upper floor levels must have gates or railings. Prohibit the removal of ceilings or coverings. When necessary to temporarily remove these see that they are replaced.

Covered Platforms Over Sidewalks.—It is desirable in all cases where public passes new building to either block off sidewalk or else erect a substantial protection shed. Sheds should have railing on street sides, and solid, high fence on building side. See that walk is smooth and even and has no projections to cause tripping. Passageways must be well lighted, with red lights at each end at night.

Plaster and Stucco Investigation

During the past 10 years investigations have been conducted at the U. S. Bureau of Standards with the object not only of improving stucco but of developing more permanent and pleasing finishes of this type for residence construction. The results of this work have formed the basis to a large extent of the "Recommended Practice for Portland Cement Stucco" adopted this year in revised form by the American Concrete Institute.

In the summer of 1922 a group of 10 new experimental panels, each approximately 8x16 ft., was erected on the Bureau's test structure to compare the effects of various types of reinforcing lath and fabric, commonly used as bases for cement stucco. While these panels were a disappointment in respect to freedom from defects, they served to concentrate attention upon the importance of the method of attachment of the lath or fabric to the supporting wood frame, and also to the value of applying and "curing" the stucco according to correct principles.

The suggestions from the 1922 investigation, together with a mild controversy as to the merits of sheathing versus no sheathing on stucco houses, led to the Bureau to plan a new investigation which might establish with greater certainty some of the questions now in dispute. Upon taking up the matter with interested associations and manufacturers, a very lively interest was shown, and as a result the co-operation of the National Lumber Manufacturers' Association, the Portland Cement Association, the Associated Metal Lath Manufacturers, and a number of individual manufacturers of wire lath and fabric has been obtained in furthering the investigation.

The work is now in progress and involves the replacement of 32 of the old panels on the stucco test building. New panels will be erected during the favorable weather condition which usually prevail in Washington at this season, and it is expected that these will be completed early in November.

The Deterioration of Structures in Sea Water

Editorial Review in Engineering, London, of Report of Committee of Institution of Civil Engineers

The Department of Scientific and Industrial Research has just published the Third Interim Report of the Committee of the Institution of Civil Engineers that has been engaged since 1916 in investigating the deterioration of structures in sea water and allied subjects.*

The present report records a considerable amount of work done in pursuance of the general scheme of investigation, together with a few results to be deduced from them, while an abstract is also given of the 1921 report of the San Francisco Bay Marine Piling Committee instituted by the American Wood Preservers' Association, which is proceeding with a vigor which has been enhanced by reason of a recent serious outbreak of activity of wood-boring molluscs in the bay.

Test Specimens of Steel and Iron Bars.—The specimens—bars 24 in. by 3 in. by ½ in.—of steels and wrought and cast-iron prepared under the direction of Sir Robert Hadfield in order to test the action on them of sea water and the atmosphere during prolonged exposure, have reached their destinations and are placed in position. Each set of these specimens includes a medium carbon steel with low sulphur and phosphorus with a duplicate sample ground all over; a mild steel with low manganese and high sulphur and phosphorus; a mild steel with 0.7 per cent manganese and a duplicate ground all over; a steel with 13½ per cent chromium; steels with 3½ per cent and 36 per cent nickel; Armco, Low Moor and Swedish wrought iron, and Lilleshall hot and cold blast cast-iron. Except as stated every bar was left with its original skin on. All bars were drilled top and bottom with one or more holes, the position of which corresponded to a code giving the class of material according to the above list and the individual specimen numbers out of the 1,330 bars that had been prepared and weighed.

At each port of observation sets of these bars, secured in frames by concrete extending to beyond the holes (the exposed surfaces being carefully measured) were totally submerged below the lowest low-water level, others were fixed midway between high and low water levels, so as to give the effect of alternate wet and dry conditions, and others were placed well above the highest high-water level, so as to give the effect of aerial conditions in the neighborhood of the water. In each case three series of such sets have been exposed, these being intended for removal at the end of 5, 10 and 15 years respectively, with periodical observations in the meantime. A fourth series was prepared for fresh-water experiments, and a fifth—how distinguished from the first is not stated—for exposure in sea water and removal after five years.

Further series of specimens were prepared for the purpose of indicating any electrolytic effect resulting from contact of dissimilar metals. Three of these pairs were arranged with their faces flat against each other. These pairs consisted respectively of medium steel and 36 per cent nickel steel, of mild steel with high sulphur and hot blast cast-iron, and of mild steel containing 0.7 per cent of manganese ground all over and Low Moor iron.

Another bar of the high-sulphur mild steel was provided with four ⅞-in. rivets, as was also one of the chromium steel, while four ⅞-in. bolts secured by nuts were put through each of four separate bars of the 0.4 per cent carbon and 36 per cent nickel steels, and the hot and cold blast cast-irons. Further, a frame was built up of two bars of 0.7 per cent manganese mild steel, ground all over, and two bars Swedish iron, secured at the four corners by ⅞-in. rivets, while a similar frame was made of chromium steel and Low Moor iron. Bars of medium steel with low sulphur, 36 per cent nickel steel, and Armco iron were bent to a right angle and secured so that the angle was fully exposed to

*Deterioration of Structures of Timber, Metal, and Concrete Exposed to the Action of Sea Water: Third (Interim) Report of the Committee of the Institution of Civil Engineers. Edited by P. M. Gosthwaite, Secretary of Committee, and Gilbert R. Redgrave. H. M. Stationery Office, London (80 ct.).

corrosion. Only one set of these composite or bent specimens was sent to each port; they are to be removed at the end of 5 years.

Results of Tests of Steel and Iron Bars.—These sets of specimens have been exposed in Plymouth, Auckland (N. Z.), Colombo and Halifax (N. S.), these ports being selected to represent temperate, warm and cold climates respectively. The Plymouth and Colombo collections were exposed in April, 1922, and no results obtained with them are yet reported. The Auckland collection was exposed in September, 1921, and in a report by W. H. Hamer, the engineer to the Harbor Board, particulars are given of the appearance of the aerial and the wet and dry specimens after six months' exposure. With the exception of the nickel steel all the aerial individual bars showed considerable corrosion, amounting in some cases to flaking, while the composite or bent series were on the whole in a better condition, the bolts being less affected than the bars, but with two exceptions all bars in the riveted frames were corroded except where sheltered. Most of the wet and dry individual bars were more or less heavily rusted and overgrown with small white barnacles, some pimples of red rust being also occasionally seen. All the composite and bent bars except one were much rusted and corroded, and considerable corrosion was found in the frames, "with the exception of well-preserved bolts," of which, however, no mention is made in the committee list's of specimens. A detailed statement is stated to be given in Mr. Hamer's report of the precise condition of each specimen.

The Halifax collection was exposed in September, 1921, and from the summary given of the report by C. E. W. Dodwell, the harbor engineer, it appears that the aerial and wet and dry specimens were observed after three months, and the whole collection just after five months. At the earlier examination all the aerial individual bars had stood very well except those of wrought iron (much corroded on the surface, but showing no perceptible pitting), and so had the aerial composite bent specimens, but the riveted frames and perhaps (the summary is not clear on the point) the composite mild steel with 0.7 per cent manganese and Low Moor iron showed signs of surface corrosion. All the wet and dry specimens were more or less corroded on the surface, though without perceptible pitting, the wrought irons being the most affected among the individual bars and the cast-iron the least, while in the composite specimens the pair made of mild steel with high sulphur and hot blast cast-iron were the least affected. Neither the aerial nor the wet and dry specimens had changed perceptibly at the later examination, except that the Galahad bar (it is not said from which condition of exposure) showed a little very slight pitting. At the later examination the submerged Galahad steel, ground mild steel with 0.7 per cent manganese, and Low Moor and Swedish charcoal irons were much corroded on the surface with a "soft blister-like or frothy looking corrosion." The other individual bars were all slightly corroded on the surface, but with no perceptible pitting surface, but with no perceptible pitting beneath. In the composite and bent series the pair made of ground mild steel with 0.7 per cent manganese and Low Moor iron and all bars in the riveted frames were much corroded on the surface, though with no perceptible pitting beneath; all the other bars were slightly corroded on the surface; all rivet heads were also much corroded on the surface, but the bolts and nuts were hardly affected.

No analyses of the sea water are given. The specimens were protected during transit by petroleum jelly, which was directed to be thoroughly wiped off before exposure. An examination by Dr. J. N. Friend of mild steel plates that had been coated with the jelly and kept for thirteen months showed slight rustiness, with a loss of weight of the order of 0.015 per cent to 0.03 per cent, an amount that would be negligible in the thick bars used for the research.

Experiments on Corrosion of Alloys.—Dr. Friend has also made two incidental reports on associated subjects. In the one he considers replies received to 10 questions that had been submitted to 50 shipowners, railway companies and large users of paint and other protective coatings employed to preserve steel and iron structures exposed to sea action, intended to elicit their experience, practice and difficulties. The results show much diversity of practice, which seems to call for further research, and the committee are considering the possibility of making experiments to test the

relative merits of some protective preparations and the methods of their application.

In his other report Dr. Friend describes some interesting experiments on the susceptibility of strained iron and iron alloys to corrosion in neutral media. From seven tensile test bars of material that were to be included in the exposure tests, and that had been heat-treated and broken under test, sections were cut at three points, one from immediately under the grips, where the material could be regarded as free from appreciable strain, and the other two through points near the fracture at which the elongations had been determined previously, and had shown respectively that the metal was in its most strained condition and in about half that amount of strain. The sections weighed about 20 grams each, and each could be assumed to be strained uniformly throughout its small bulk.

Each of these specimens was carefully machined and polished. It was found that without exception the specific gravity of each material had fallen as the strain increased, thus indicating that the type of cold-working that is applied in a tensile testing machine reduces the specific gravity of the metal. Other specimens were kept for a year on blocks of paraffin wax in a tank, which was alternately filled with tap water and emptied by syphonic action, so as to give alternately wet and dry conditions. The materials thus tested were the Low Moor iron (0.015 per cent carbon and a trace of manganese), Armco iron (0.035 per cent carbon and 0.065 per cent manganese), mild steel (0.24 per cent carbon and 0.68 per cent manganese), medium carbon steel 0.345 per cent carbon and 0.71 per cent manganese), carbon steel 0.40 per cent carbon and 0.85 per cent manganese), nickel steel (0.12 per cent carbon and 36.6 per cent nickel), and Galahad steel (0.36 per cent carbon and 13.57 per cent chromium).

As a result the irons and non-alloy steels not only showed no appreciable difference in corrodibility between strained and unstrained specimens—in three out of the five materials the strained specimens showed in fact a shade less corrosion measured by loss of weight than the unstrained—but the actual difference in corrosion between the several unstrained materials were insignificant—5 per cent or less. Both strained specimens of nickel steel, the other hand, showed about 4½ times the corrosion of the unstrained specimen. The strained chromium steel specimens also showed respectively a third more and double corrosion as compared with the unstrained, though Dr. Friend remarks very fairly that that differences—respectively one-tenth and three-tenths of a milligram—almost lie within the range of experimental error. Dr. Friend points out that the results given by the non-alloy metals are quite consistent with increased corrodibility of strained material in practice, seeing that under the conditions of experiment each specimen was probably strained uniformly throughout its bulk and insulated from any metal in another state of strain, neither of which conditions would be present in practice. Perhaps if the experiments are repeated controls will be arranged in which contact will be made between strained and unstrained sections of the same specimen. It seems possible, too, that the assumption of uniform strain throughout the entire section may be less warrantable in the presumably far stronger and tougher alloy steels than it is in the irons and straight steels.

Effect on Reinforced Concrete.—In 1917 a number of slabs of reinforced concrete were exposed in the Brisbane River at a point where the water was practically as salt as sea water, the blocks varying in the extent to which the reinforcement was covered, and to some extent in the composition of the concrete. From a note by E. A. Cullen, engineer to the Harbors and Rivers Department at Brisbane, it appears that although less additional rusting than had been expected has occurred since the last examination eighteen months ago, nothing less than 2 in. covering is sufficient, so far as these observations go, to give complete protection. In the blocks with thinner coverings little difference has been found in the deterioration between 2 sand-1 cement concrete and 4 sand-3 cement. In a reinforced concrete wharf on the Brisbane River completed by Mr. Cullen in March, 1917, the piles and girders have 2-in. cover over the reinforcement, and the whole structure was well tarred with hot distilled tar on all surfaces except the deck, the tar being carried down the piles to about the level of mean neap high water, and the tarring

being repeated a year later. Below mean sea level the piles are encrustd with small barnacles, but on recent examination, five and a half years after completion, no corrosion had occurred.

Timber Investigations.—The investigations of timber continue to reveal wide differences in the experience of different observers. The most comprehensive account of the practical occurrence of organisms attacking timber is given in a report on boring organisms in various waters by J. E. Cunningham, the inventor of the carbo-teredo process for protecting timber against such organisms. This process consists in coating the timber with vaseline, which is then strongly heated and ignited with a hand lamp, so that the timber is more or less evenly and deeply charred. Knots in the timber are then impregnated again and recharred; so are cut ends, the char being consolidated by hammering up. On the basis of timbers so treated and kept both in quiet waters and in the open sea for three to seven years Mr. Cunningham claims that both pine and hardwood so treated are proof for at least that period against sea worms, the animalculæ on which they feed, and other organisms that attack timber, while even turpentine wood, if untreated, is badly attacked when placed side by side with intact treated lumber. On the other hand, W. H. Hamer found turpentine wood stand sound for four years, whether treated or not, under conditions in which a number of other woods treated by the carbo-teredo process were attacked or even destroyed.

To what extent the failures of the process reported by Mr. Hamer have happened because it does not always protect or (as in general terms Mr. Cunningham explains such failures as he has himself known), because it has not been properly applied, is not clear on the published particulars. What, however, is clear from these reports and another by A. C. W. Fosbery, the chief engineer of the Bombay Port Trust, and the experience of the San Francisco Bay Marine Piling Committee, is that few, if any, untreated timbers can offer prolonged resistance to the attack of organisms, and that no completely adequate means of protection has as yet been demonstrated.

Studies of Marine Boring Organisms.—Accordingly, the most hopeful of the Committee's labors may be the various investigations into the fundamental facts of the life history of marine timber-boring organisms, the circumstances and methods of their lodgment and attack, and their reactions to various protective substances or processes. In one series of experiments, Dr. George Barger supplied Professor S. M. Dixon with a number of "poisons" insoluble in water, but soluble in alcohol, of which 1 per cent and 0.1 per cent solutions were impregnated into blocks of wood, and exposed for a year off Lowestoft pier. The impregnation appears mostly to have penetrated only ⅛ in. to ¼ in., and all that can be said of the results is that they show clear differences between the poisons, which might be more apparent—or less—if the impregnation had been less superficial. For the period in question impregnation with creosote, which penetrated throughout the substance of the block, was completely effective, as were two of the poisons.

Under Dr. Barger's direction, also, C. B. Harrington carried out a number of experiments in Plymouth Sound and in a laboratory, which, among other results of scientific importance, showed that in the presence of appropriate food are larvæ of the organisms in question could swim about for a fortnight, and thus might infect timber at a considerable distance, and that they are definitely attracted by certain chemical substances. Professor Dixon describes the methods he used for creosoting and applying "poisons" to timbers, during which he noticed considerable differences between the extent to which various timbers absorbed the impregnating solutions. An interesting detail of the method is that in all cases the blocks were furnished with a veneer of untreated wood, which enables organisms to get a start and attack poisoned woods which they failed to attack in the absence of the "appetizer" veneer. Professor Dixon has also carried out a large number of mechanical tests on specimens of timber, from the Colonies and elsewhere, both untreated and after creosoting, the results of which will be published later.

The Strength of Short Concrete Beams

Results of Tests Given in the August Journal of the Engineering Institute of Canada

By J. B. MACPHAIL,
The Shawinigan Engineering Company, Ltd.

The design of reinforced concrete beams, loaded on spans of less than four times their depths, has received little attention either theoretically or experimentally, and the experiments herein described were undertaken in the hope that they might furnish some information that might be of use to designers.

Test Beams.—The elements of the beams tested are given in Table I. The beams were all 6 in. in breadth and 6 in. longer than the spans listed. All rods had hooked ends and were made from ordinary commercial round bars; in every case three rods were placed with their centres 1½ in. from the bottom and 1½ in. from centre to centre and from the sides of the beam. When five rods were used, the additional two were placed with their centres 3 in. from the bottom and covered the spaces in the lower layer. The sand used had a fineness modulus of 2.68 93 per cent passed a No. 14 sieve; 34 per cent passed a No. 28 sieve and 6 per cent passed a No. 48 sieve. The aggregate was ¾ in. limestone chips containing some dust. The concrete was hand-mixed in proportions of 2:4:6 with sufficient water to give a slump of 4 to 6 in. in a 6 in. x 12 in. cylinder. Water was poured over beams and test cylinders once a day from the 4th to the 28th day after mixing.

Using unit stresses of 750 lb. per sq. in. on concrete and 16,000 lb. per sq. in. in the steel, values of *W1*, the safe central concentrated loads, were calculated. In order to keep bond stresses down to reasonable values all but beams *G* and *K* were over-reinforced; so that in these two the resisting moment of the steel was less than that of the concrete; in the others, the concrete resisting moment governs. For these loads the unit shear *v* and the bond stress *u* were calculated.

The beams were tested at an age of 56 days under a central concentrated load on the Emery testing machine in the strength of materials laboratory at McGill University.

Results of Test.—The observed ultimate loads *W3* are given in Table II together with safe loads *W2* based on a unit shear of 56 lb. per sq. in., a usual value for beams without web reinforcement. *W3÷W1* give factors of safety *F1* and *W3÷W2* give factors of safety *F2*. This method of presenting results is due to Dr. Oscar Faber.

Results obtained by using the loads observed at the first drop of the indicator of the testing machine gave figures of the same character as those tabulated.

In general failure occurred through diagonal cracks starting at or near the supports and running up to a point beneath the load; sometimes by vertical cracks below the load.

Table II.

Mark	W2 lb.	W3 lb.	F1.	F2.
A	4,430	56,000	3.4	12.6
B	4,880	44,400	4.2	9.1
C	5,060	25,600	3.6	5.1
D	5,060	17,600	3.1	3.5
F	6,000	39,600	3.5	6.6
G	6,070	31,000	4.1	5.1
H	7,950	98,300	4.2	12.4
K	8,570	33,800	3.1	3.8
		Mean	3.65	7.3

The observed ultimate compressive strength of four 6 in. x 12 in. test cylinders at 8 weeks averaged 3080 lb. per sq. in. so the observed average factor of safety requires a reduction to the basis of an ultimate strength of 1875 lb. per sq. in. at 4 weeks, 40 per cent of which was taken as the working stress. To form a rough estimate, assume that the ultimate load carried by a beam is proportional to the ultimate strength of the concrete of which

Table I.

Mark	Reinf.	Depth in.	Span in.	W1.	v.	u.
A	5x9/16	10¼	17	16,250	205	139
B	3x⅝	10¼	27	10,600	121	124
C	3x½	10¼	36	7,080	78	100
D	3x½	10¼	45	5,660	63	80
F	3x9/16	12	33	11,250	105	119
G	3x½	12	44	7,630	70	90
H	5x½	16	28	23,300	164	125
K	3x½	16	43	11,000	72	91

it is made. The ultimate loads for the weaker concrete would then be

$$W3 \times \frac{1875}{3080}$$

and the observed factors of safety *F1* would be reduced in the same ratio or

$$F3 = F1 \times \frac{1875}{3080} = 2.22$$

average, which agrees fairly well with the assumed factor of safety of

$$\frac{1875}{750} = 2.50.$$

Further, the value of the denominator 3080 in the above expressions should be reduced slightly to bring it to its value at 28 days. A value of 2740 lb. per sq. in. as the ultimate strength of the test cylinders at 28 days would give a factor of safety *F3* of 2.50 and an increase of 11 per cent give 3040 lb. per sq. in. The probability is that the increase in a further 28 days is more than 11 per cent so the true strength at 28 days is probably lower than 2740 lb. per sq. in. This would slightly increase the factor of safety from 2.50. It may be mentioned that the tentative report of the Commission du Beton Arme de l'Association Belge de Standardisation contemplates an increase in strength of 50 per cent between 28 and 90 days.* In any case the reduced factor of safety *F3* is not far from the value of 2.50 assumed.

This revision of concrete stress is applicable also to the factors of safety *F2*, but this would not alter the fact that the values of *F2* vary over a much wider range than values of *F1*.

The small variation in factors of safety *F1* for the design loads in which bending and bond stresses only were considered and the high values of the unit shear neglected, show that the concrete was economically used, whereas a design based on a maximum unit shear of 56 lb. per sq. in. would waste concrete in some cases, as shown by the unnecessarily high factors of safety *F2*, though a little steel might be saved.

Shear Stresses.—To explain the action of the shear stresses reference may be made to the works of Dr. Oscar Faber who has developed a theory of the existence in a loaded reinforced concrete beam of a series of direct and indirect inclined compressions which, together with the steel, resist the shear. This theory is given briefly in "Reinforced Concrete Design" by Fabor and Bowie, vol. 1, p. 79 ff., and at greater length in his paper "The Shearing Resistance of Reinforced Concrete Beams"** read before the Concrete Institute in London in May 1916.

The application of Dr. Faber's methods to this particular type of beam and loading gives safe loads, based on shearing stresses, that are identical with those determined from considerations of bending, and the uniformity of the factors of safety *F1* confirm his deduction that in a simple beam having reinforcement with sufficiently hooked ends running the whole length at a distance from the bottom not less than 1/3 kd, failure will not occur until the full moment of resistance has been reached, and that if the safe bending stresses are not exceeded, the safe stresses elsewhere will not be exceeded.

It may be argued that the use of a greater amount of steel, to reduce bond stresses, than would be required to resist the applied bending moment caused the ultimate loads on the beams so treated to be higher than they would have been if the bond requirements could have been met by steel of a smaller total area, because of the smaller unit stress and the consequent smaller deformation of the steel. This can be positively decided only by experiment, but the theory does not indicate such a result and practical considerations of bar spacing and construction would doubtless prevent much alteration in this direction where short spans are concerned.

It may be concluded then that short beams simply supported, if designed for safe moment and bond stresses, do not require web reinforcement.

Grateful acknowledgement is tendered to McGill University for facilities for testing the specimens; to Professor Ernest Brown, M.E.I.C., and S. D. MacNabb, A.M.E.I.C. for making the tests, and to J. A. McCrory, A.M.E.I.C. for facilities for making the specimens and for assistance in testing them.

*"Pratique du Calcul du Beton Arme" by G. Magnel, p. 128. Published by Van Ryssel-berghe & Rombaut, Ghent, Belgium.

**This paper was published in "Concrete and Constructional Engineering" in England in May 1916 and subsequent numbers. Copies of the paper can possibly be obtained from the secretary of the Concrete Institute, at 296 Vauxhall Bridge Road, London, S.W., England.

Ready-Cut Houses

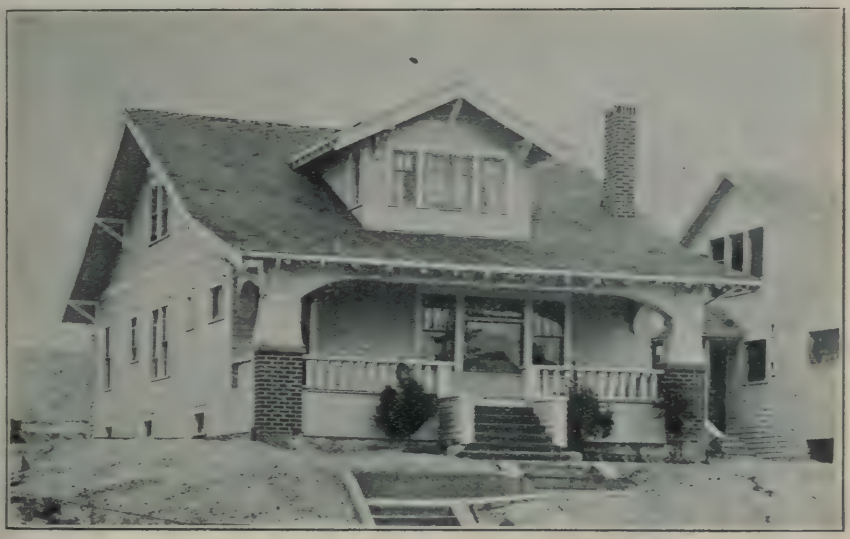
Advanced Types and Methods Developed by a Western Washington Lumber Company

The Tumwater Lumber Mills Company of Tumwater, Washington, has devoted especial attention to the production of ready-cut houses of attractive design, and as a result has evolved some 45 styles, three of which are pictured in this article. The designs are worked out for convenience of interior arrangement, as well as for pleasing effects both interior and exterior, thus meeting the present day requirement of combined beauty and efficiency at a cost substantially less than for a home of equal merit designed and built individually. Modifications of the designs can be made at moderate cost, or in some cases at no cost, providing they involve no radical changes in the main features. Additional styles are from time to time being added to the list.

The framing and construction of these houses conforms to the recognized best practice in construction where all material is cut on the job. All the structural features have been carefully designed, thus avoiding both the wastefulness and the weaknesses which are not uncommon in designs where the loads and stresses are not actually computed. In filling an order, the lumber company furnishes a complete set of plans, an itemized set of materials and a full set of instructions for erection. The company furnishes all lumber, hardware and glass, but except under special arrangement does not furnish brick, stone, sand, cement or plaster.

Floor plans, elevations and details are of the usual assortment and type furnished by architects, but the framing plans are given in greater detail. A system of index letters and numbers carefully worked out for convenience connects the framing plans with the bill of materials and with the materials themselves. The bill of material lists separately the number of pieces of each kind, the dimensions of each and the index reference. A fourth column provides space for such special references or remarks as may be needed. The framing plans bear the reference symbols marked on each member.

All top or bottom plates are marked and numbered to show the exact location of each studding, so as to eliminate any errors in erection and assure



One and One-Half Story House from Ready-Cut Material and Plan.

an accurate fit. The system of marking is based on assigning index letters to each side of the house or partition and to each section, such as joist, rafter and ceiling plan. When the material is cut and fitted, each piece is marked with this index, showing the particular side or part of the house where it belongs and following this index mark, the number showing the exact location, is printed.

Material of the same kind and for the same section of the house is bundled in groups and each bundle is marked with the index and group letter, which permits the placing of material where it belongs when unloading and thus saves rehandling later. All the marks on the various pieces correspond with the same marks shown on the drawings. This system makes the marking and sorting of the material very simple and by placing all the material marked with the same index or group letter to the side of the house where it belongs, according to the drawing, the material can be located at a glance.

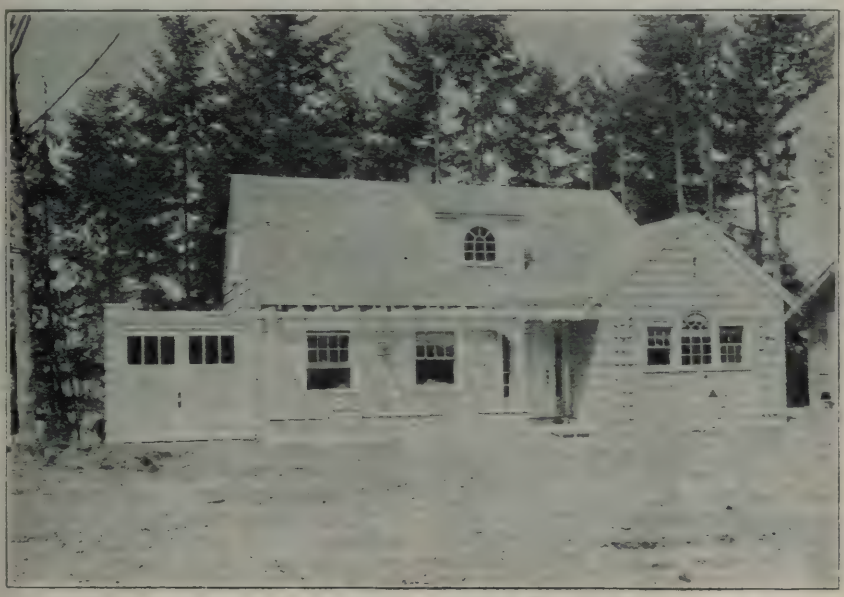
All finishing lumber for doors, windows and built-in features, is crated so as to protect it from damage in transit and each crate contains all the parts belonging to a door or window as the case may be, with proper identification mark showing its location according to the drawings. The built-in features such as kitchen cabinet, buffets, etc., are all factory-made. Porch beams, brackets, steps, stairways, are all made as near complete as possible. The studdings are cut from a gauge and are therefore all of the same length and truly square ended, thus insuring a uniform load on all the studdings. The plates are all cut and marked for the studdings and openings and this makes the walls plumb and true. The sub-floor is cut except where it is desired to run diagonally in which case one end is cut at 45 degrees. The shiplap wall sheathing is cut and beveled even for the gable pieces. The rafters, roof sheathing, cornice ceiling, verge boards, etc., are also all cut to fit.

Colonial Type Ready-Cut.

Economies resulting from the use of this system are of three principal classes: First, the saving in carpenter labor which results from the elimination of the cutting of lumber and the reduction of planning on the job to a minimum. Officials of the Tumwater Mills state that in actual practice they have found savings of between 50 and 60 per cent in the cost of framing, and average savings of from 35 to 40 per cent on total carpenter labor cost including interior

finishing. The second saving is in waste material. The Tumwater Lumber Mills cut their own lumber from the logs and have an extensive trade outside of that in ready-cut houses, so that they are enabled to select all material for the ready-cut business from lengths that reduce waste to a minimum. There is thus a saving in both material and freight costs on the amounts which are usually cut off and wasted on the job. The last saving is in the shipping and handling charges. These manufacturers consider that the local dealers are the logical salesmen for their product, and therefore deal through them in preference to the older practice of marketing their product direct; but although the orders are taken locally, shipments are made direct from the mill to the job. This practice not only saves in handling but eliminates storage, depreciation and other items.

The lumber is all Douglas Fir. Shingles and siding are of red cedar. Complete shipping weights on all material, adjusted to absorb the differentials on shingles, paint, hardware and finish, and so to give a straight lumber rate on the entire shipment range according to the style of house from 29,500 lb. to 82,000 lb.



An Attractive Modern Type.

Gypsum Production in Canada

The Dominion Bureau of Statistics has issued the following finally revised statistics on the production of gypsum in Canada during 1922.

The total output of gypsum rock in Canada during 1922 amounted to 484,629 tons; of which quantity 145,954 tons or 30 per cent was calcined. The quantity quarried, by provinces was: Nova Scotia 281,861 tons; New Brunswick 56,692 tons; Ontario 106,829 tons; Monitoba 39,147 tons; and British Columbia 100 tons.

Shipments of all grades totalled 559,265 tons valued at $2,160,898, an increase of 172,715 tons and $375,360 over the 1921 production.

Supervising Architect Wanted for Canal Zone.—The U. S. Civil Service Commission, Washington, D. C., has announced an open competitive examination for supervising architect to fill a vacancy in the Public Works Department, Office of the Commandant, Fifteenth Naval District, Balboa, Canal Zone, at an entrance salary of $10 a day, and vacancies in positions requiring similar qualifications.

Estimating Painting Jobs

Suggestions on Amount of Material and Time Required Given in Paper Presented at Convention of Iowa - Nebraska Master Painters and Decorators Association

By GEORGE A. STEINHEIMER

Two Methods of Estimating.—One is the figuring of actual cost of labor and material for the entire job, to which is added overhead, insurance, railroad fare and expenses, if the job be out of the city, and the cost of a bond, if same is to be furnished, and to the total of this, which makes up the actual cost, is added a fair and suitable profit.

The other method used by equally responsible contractors is that of including overhead and profit in the various unit prices, which are to apply to the various items on that particular job. The total of these figures will be the price of the job and includes overhead and profit. The latter method is apt to find us bidding work at actual cost due to our failure to include proper overhead and profit in each unit price used to make up our estimate.

I was approached by a painter of long experience a short time ago, who asked what I considered actual cost of labor and material for two coats of lead and oil and stipple on smooth plaster. My answer was that on large yardage, the cost would be 28 cts. He told me that he had asked several painters the same question and the answers received ranged from 20 to 40 cts. per yard. Is it any wonder that bids vary when we disagree so widely on so simple a proposition?

Material Can Be Estimated Accurately.—If we are careful in our measurements, taken either from plans or from the building, we can estimate the amount of material required very accurately, but the labor presents a much more difficult problem, owing to the different classes of work, and the difficulties experienced in applying the paint. In other words, the amount of paint required will be the same on a plain surface as on an ornamental cornice, but the labor will be much greater on the latter on account of the amount of cutting in or trimming required.

On account of the prices of material changing, and the cost of labor varying in different localities, I shall not attempt to set down actual prices, but will try to give you some figures, covering in a general way the amount of material required for certain kinds of work, and the possible amount of time to apply the same.

Material and Labor Requirements.—We will begin with the priming of the outside. One gallon of properly mixed lead and oil or a good grade of mixed paint will cover 60 sq. yd., and if you use the same figure for your second and third coats, you will be close enough for any estimate, and the painter working eight hours per day will cover on an average of 140 sq. yd. each coat.

To dip shingles in a good shingle stain, requires 2½ gal. of stain per 1,000 shingles, and a painter will dip them at the rate of 2,000 per hour.

The labor and material required for the painting of a brick building which has been painted before will be very much the same as on wood.

Finishing Interior Woodwork.—The finishing of interior woodwork will vary more on account of the different kinds of wood, and the class of finish desired. Oil stain on such woods as gum, birch, yellow pine and the like will cover from 50 to 60 yds. per gallon, and the painter will cover 140 sq. yd. in eight hours. If a spirit or water stain is used, the material and also the time required will be about 12½ per cent more.

When paste filler is used, whether colored or left natural, 5 lb. of filler, properly reduced, will make 1 gal. of filler, and this should cover 34 sq. yd., and on the average, depending entirely on the surface to which it is applied would take a painter three hours to apply the filler and wipe off with burlap.

One gallon of shellac will cover 65 sq. yd., and 1 gal. of varnish about 50 sq. yd., and the shellac can be applied in about three-fourths the time required to apply the varnish, which is from 3 to 4 hours.

The sand papering and puttying up will, of course, be in addition to this, and will depend entirely on the condition of the surface, and the results desired. The covering capacity and time required for enamel work are similar to varnish, but the sand papering between coats will be much more where enamel is used.

One gallon of flat varnish will cover about 25 per cent more surface

than gloss varnish, and the time required to apply will be slightly less. Rubbing down with pumice stone and water has become almost a lost art, sad to say, but the amount of labor required will vary according to the finish desired. One man should rub six door sides and do a first class job in eight hours.

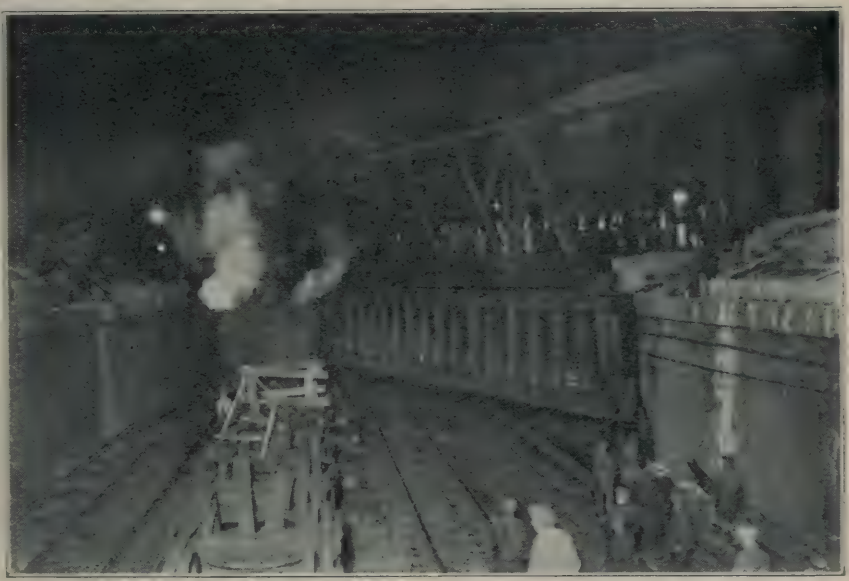
One gallon of a good flat wall paint will cover 54 sq. yd. on smooth plaster surface and with proper tools and scaffolding, one man can cover 180 sq. yd. in eight hours.

These figures will apply to the first and also to second or third coats. When lead and oil are used, the above figures will govern, but if the last coat is to be stippled, one man can stipple as much as two men can apply.

We do not do as much cold water painting or kalsomining in this section of the country as they do in other parts, however, 1 lb. of cold water paint should cover 6 sq. yd., one coat, and a painter should apply 200 sq. yd. in eight hours. For sizing walls where glue or other water size are used, one man should cover 400 sq. yd. in a day.

Placing a 98-Ton Girder

A 98-ton girder was recently placed on the main line of the Boston & Albany R. R. at Beacon St., Boston, Mass. The girder was received on flat cars, removed and held in suspension by an Industrial crane. The job was done at night between train schedules, from 10 p. m. to 1:55 a. m. The Phoenix Bridge Co. was the contractor.



Industrial Crane Placing a 98-ton Girder on B. & A. R. R. at Beacon St., Boston, Mass.

Method of Preventing Cracks in Concrete Tennis Court

To avoid cracks in a concrete tennis court, states Concrete, wire mesh reinforcement should be used and but one expansion joint along the net line. Keep the concrete wet all the time by the ponding method or by sand covering for at least a week. To obtain a green color in the court use a good quality of chromium oxide. This color is expensive, so it should be used in a thin topcoat only and this topcoat should be placed before the base concrete has hardened. Use no more than 6 to 8 lb. of color to 100 lb. of cement, the cement and color preferably to be ground together before the sand and water are added.

Building Foundations in Clay

Bearing Values, Detroit Tests and Porcupine and Fan Caissons

By CHARLES EVAN FOWLER,
Consulting Engineer, New York and Detroit.

The making of foundations in clay requires the most careful study of conditions of any class of material, owing largely to the amount of water contained in it, and the possible action of water upon a particular bed of clay.

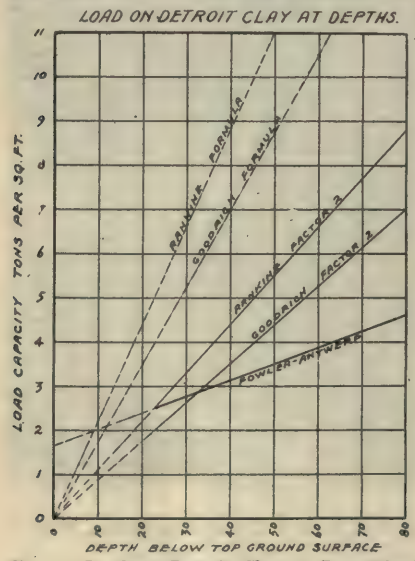


Fig. 1.—Load on Detroit Clay as Determined by Various Formulas.

General Classes of Clay.—The five general classes of clay are: (1) yellow clay, of a yellowish color, and containing a large percentage of sand or ordinary earth; (2) red clay, of very marked red color, and containing a large percentage of sand or ordinary earth; (3) gray clay, or ordinary compact pure clay; (4) blue clay, which is of a decided bluish color, and is a compact or very hard pure clay; and (5) gray or blue clay, which is so very hard and compact that it is termed "hardpan."

The condition of the first four classes is that they are usually moist or damp, but are sometimes so wet as to be unstable and apt to slide. When practically dry, or only moist or damp, clays are first class as a foundation bed, and may be considered better than dry or moist sand, or loose gravel, but when very wet they are to be looked upon with suspicion, unless a sure method can be devised for draining them, or of draining the water away. Hardpan is nearly always a good foundation, and usually remains hard under water, but may have a tendency to slide if water can or does follow through seams or softer underlying strata, that cannot be drained away in some sure manner.

Determination of Character of Clay.—The determination as to the character of clay for a foundation, must depend largely upon careful borings. They should be made in large enough number so as to construct the geological sections, and thus prove that the clay is in strata and not simply pockets or lenses. The borings may be made by the wash boring process, and the samples taken frequently by first bailing or pumping out the water, and then a tube driven one or two feet to take out a core or real sample. Where the material is very solid, a core boring machine may be used to remove an exact core. Where difficulty is had by reason of soft overlying material, a casing may be sunk to the hard material by the wash boring process, and then a core boring taken in the hard material. Where the material is of a fairly well-known character and the foundations not likely to require great depth, some

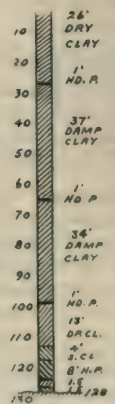


Fig. 2.—Typical Detroit Boring.

est pits may be dug to prove the character conclusively.

Weight of Clay.—The weight of ordinary clay is usually stated at from 100 to 115 lb. per cu. ft., but some of the denser clays will very much exceed this, as at Detroit, where the clay has a weight of from 130 to 140 lb. per cu. ft.

The nomenclature of clay varies in each locality, and what is termed soft in one locality, would represent a medium soft clay elsewhere, and perhaps a medium hard clay in some

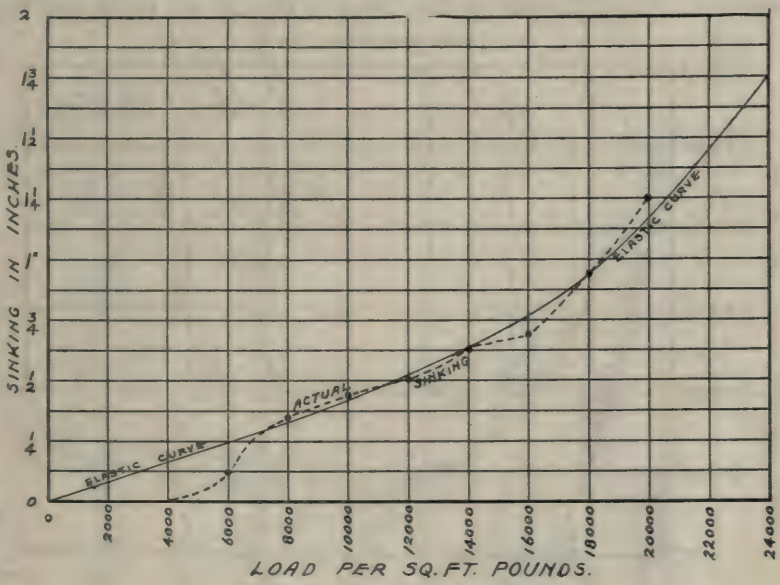


Fig. 3.—Test on Detroit Clay.

other location. So that great care must be exercised in studying borings and data, to make sure just what was intended or meant by any given record of borings.

The weight, the angle of repose, and the angle of internal friction of clay, in the dry and under water, are given in Table I.

Carrying Capacity.—The carrying capacity per sq. ft. for the various grades of clay on its top surface, may be assumed as follows for preliminary values.

Basic Bearing Values. P or H=0 to 23 ft.

Kind of Material	Weight Cu. Ft. Lb.	Load Per Sq. Ft. Tons
Ordinary Dry Clay and Ord. Clay—10% Sand	100	2.0
	110	2.5
	120	3.0
	130	3.5
	140	4.0
Damp Clay and Damp Clay—10% Sand	100	1.5
	110	2.0
	120	2.5
	130	3.0
	140	3.5
Wet Clay	90	1.0
(Drained)	100	1.5
	110	2.0
Clay Under Water	70	0.5
	80	1.0
	90	1.5
Hardpan	120	6.0
	130	7.0
	140	8.0

Formulas for Determining Allowable Load.—The increase in the carrying capacity, with the increase in the depth of the foundation footing below the surface of the clay, may be de-

Table I.

Kind of Clay	Weight of Clay	Angle of Repose Dry	Slope of Repose	Angle of Internal Friction	Angle Repose Under Water
Dry Clay	110-140	29° 0′	1.8 to 1	10° 0′	15° 57′
Clay (with Sand)	110-120	36° 53′	1.3 to 1	10° 0′	18° 26′
Damp Clay	100-110	26° 34′	2 to 1	6° 30′	15° 57′
Wet Clay	90-100	20° 0′	3 to 1	3° 0′	15° 57′
Under Water	70-90	15° 57′	3.1 to 1	2° 30′	15° 57′
Hardpan	120-140	45° 0′	1 to 1	15° 0′	45° 0′

termined by any one of the three standard formulas, the Rankine, the Goodrich, and the Fowler-Antwerp. The first named giving the greatest values, and the last named the most conservative values, as shown by the diagram for Detroit blue clay, weighing 140 lb. per cu. ft. The diagram (Fig. 1) gives also the reduced values for the Rankine and Goodrich formulas where it is necessary to keep within conservative loading values to have only a slight settlement, by applying a safety factor of two. The conservative values obtained by the Fowler-Antwerp empirical formula are well within ordinary settlement values.

The Rankine formula is

$$P = W\ H\ \tan^4 \sqrt{450 + \tfrac{1}{2} A}$$

The Goodrich formula is

$$P = 2.5 \times W \times H$$

The Fowler-Antwerp formula is

$$P = 0.68p + 0.014pH$$

In which the values are:

P = allowable load in pounds per sq. ft.
W = weight of material lbs. cu. ft.
H = penetration of footing in feet.
A = angle of repose of material.
p = allowable load 23 ft. below surface.

The last named or the Fowler-Antwerp formula is recommended for use in all important or high buildings, and especially for all buildings where an undue amount of settlement would be likely to crack stonework, plastering, or any ornamental work.

Settlement Tests at Detroit.—The settlements in clay as determined by tests with from one to 4 sq. ft. area are very unreliable, and larger areas should be used making tests or for tests piers. The tests for the Michigan Central Station at Detroit had one such pier of 68 sq. ft. on which a load of 5485 lb. per sq. ft. was maintained for 73 days, or from Feb. 25 to May 9, 1912, and the resulting settlement was only ⅜ in., the clay being much softer however than in the central part of the City, where all of the foundations for high and heavy buildings have been made for many years on or in the heavy clay, with no settlements of appreciable amounts. The character of the clay is shown by the boring section (Fig. 2) taken at the corner of Michigan Ave. and Washington Blvd. The loading test of this clay is shown by the curve in the diagram (Fig. 3) and the settlement was inconsiderable in amount. The test was made with a hydraulic jack on an area of 4 sq ft., and within a recess in a concrete pier, so that it

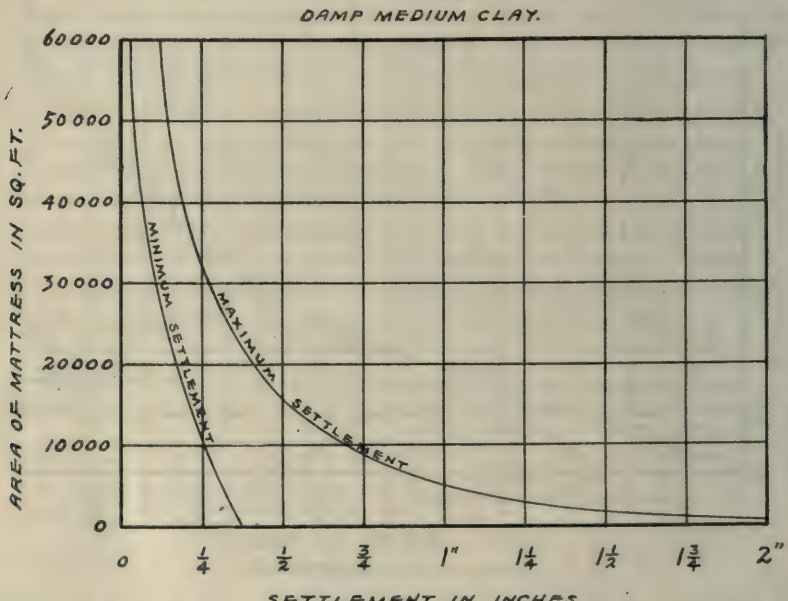


Fig. 4.—Settlement of the Large Areas.

represents closely the settlement to be expected on a spread footing of large area, and shows the true elastic curve of the Detroit clay. The tests of the

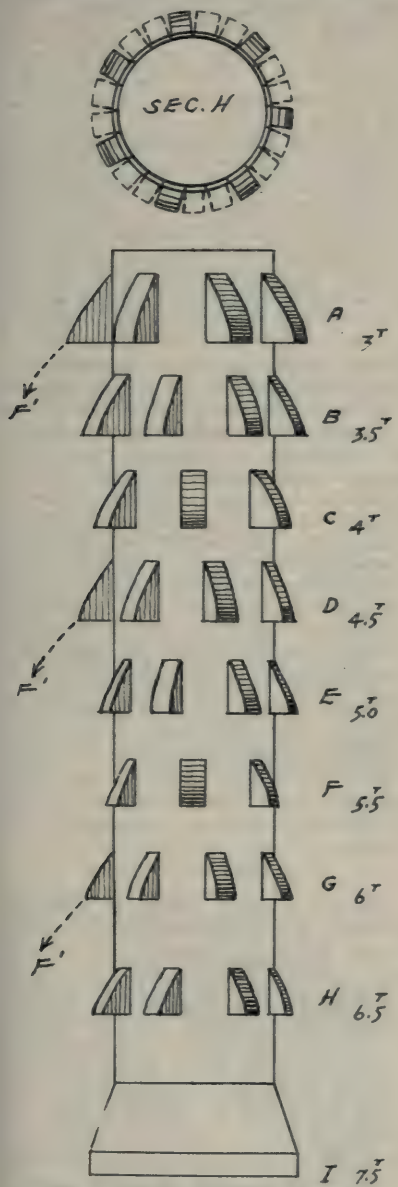


Fig. 5.—Fowler Porcupine Caisson.

clay at the site of the new Masonic Temple, corner of Temple Ave. and Second Blvd., indicated a possibility settlement of from ½ to ¾ in., which was provided for by large spread footings carrying a number of columns on each large reinforced concrete spread base.

The use of such multiple spread bases has been very common in Detroit and in many cases mattresses

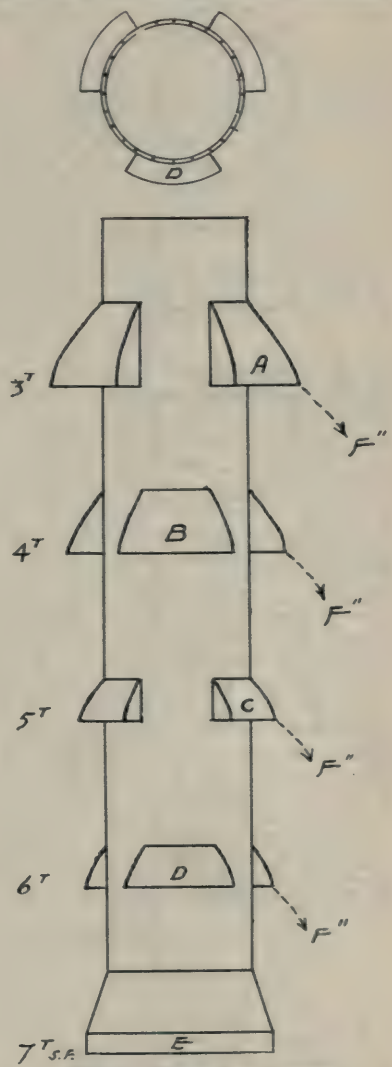


Fig. 6.—Fowler Fan Caisson.

have been used to cover the entire building area, as in the case of the Michigan Central Station for an area of nearly 60,000 sq. ft. While no definite tests have been made of the relations between the settlements of small area tests and the settlement of

such large areas, it may be confidently stated to lie between the curves shown on the diagram herewith (Fig. 4). The mattresses must be designed in sections, and reinforced in accordance with the distribution of loads

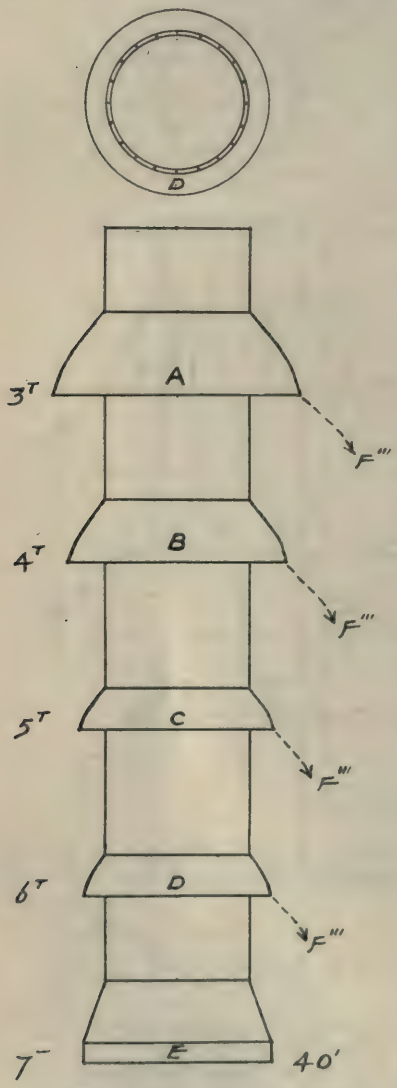


Fig. 7.—Fowler Fan Caisson.

over each section. In some cases this calls for cantilever reinforcement, and in others two or four way flat slab reinforcement as used in the plan of a 12 column section. The thickness of the sections to vary with the intensity of the loads or from 2 ft. to 7 ft. thick.

Porcupine and Fan Caissons.—While such methods insure an equitable distribution over an entire area, and prevent trouble by bridging over soft spots in the clay, it is often necessary to have the foundation cover more area, and to go to a depth not likely to be exceeded by adjacent foundations that might be constructed in the future. This may be accomplished at great expense by caissons or wells to rock, or to hardpan by belling out at the bottom, when the hardpan layer is thick enough to distribute the load over softer stratas below, or when it lays directly on the rock. However the schemes devised by the writer are covered in the invention of porcupine and fan caissons, patents for which have been applied for, shown in the illustrations (Figs. 5, 6 and 7), which by varying widths and numbers of the lugs and fans, proportioned according to the soil resistance at various depths, makes it possible to carry great loads by extending the foundations only to moderate depths. The load is distributed outward and downwards into the clay without interference with the zones reached by the lower layers or rings of lugs or fans. The larger projection of the upper lugs and rings combined with the lesser carrying capacity of the clay at shallower top depths, makes it possible to insure each ring taking its full share of the load. The bottom of the caisson may be belled out or not as found necessary or desirable.

Minimum Wage Scales in Building Trades.—Minimum wage scales on the 8-hour basis as submitted at the recent convention of the Building trades Department of the American Federation of Labor showed that bricklayers throughout the country were receiving from $1 to $1.50 per hour; carpenters, $0.85 to $1.25; plasterers, $1 to $1.50; building labores, $0.25 to $1.10; structural iron workers, $0.75 to $1.37½; plumbers, from $0.80 to $1.50; lathers, $0.70 to $1.62½; electricians, $0.70 to $1.25; stone cutters, $0.75 to $1.50. It was stated moreover that many workers are receiving bonus payments of from $1 to $4 daily in addition to the regular wage scales.

Practical Accident Prevention in Structural Work

Methods of Post & McCord, Contractors, Described in Paper Presented Oct. 3, at 12th Annual Congress of National Safety Council

By B. W. DELANEY,
Claim Agent, Post & McCord, Inc., New York City.

The only practical way, known to Post & McCord, to prevent accidents in the construction field is as old as antiquity and at the same time seems to hold good against any other form of safety as yet introduced. It is embodied in two divisions:

The exercise of eternal vigilance, or personal surveillance; and the use of the best equipment procurable.

Carelessness Cause of Many Accident.—It has been the experience of Post & McCord during the past 10 years, in which the firm has carried its own insurance, that over 95 per cent of the accidents occuring among employees working on the many steel structures erected during that period have been due to the carelessness of the injured or to that of his fellow workmen. This in itself emphasizes the necessity of constant watchfulness on the part of both employee and employer, and is supplemented by the fact that many of the most serious accidents which occurred during the period mentioned were due to the momentary carelessness of expert workers; men who had had years of experience in their trade and who were well known as the most careful and competent in their particular line. Hence it is considered necessary to keep in constant and intimate touch with the men in the field.

How Safety Program Is Conducted.—This program is personally conducted by the Vice-President, Mr. Frank B. McCord, and by the Superintendent of Erection, Mr. William H. McCord, through direct contact with superintendents, foremen, sub-foremen, time-keepers, gang bosses, etc., on the various jobs. Every job is visited daily by either of the above men who carefully inspect and analyze, with the superintendent and his assistants, each operation and problem involved in the progress of the work, and so become acquainted with all the men and all conditions. Suggestions and criticisms are invited; infractions of rules detected; penalties inflicted; dangerous practices eliminated; and, in a word, the whole organization kept on its toes both for efficiency in production and prevention of accident. This, the firm believes makes every man a separate unit of safety. Of course, this system of supervision is supplemented by various efforts to get the men to think safety, but when it comes to influencing the human element the principal dependency is on the verbal contact established between employer and employee in the way above mentioned.

Provide Best Equipment.—In the matter of equipment, it has always been the endeavor of Post & McCord to provide the best and most modern machinery and tools obtainable for construction work. In fact, I think it may be said without fear of contradiction that the erection plant of Post & McCord is the most complete outfit of its kind in the territory of New York City. This does not merely mean that the plant is large and capable of handling big work, but rather that every tool and piece of machinery, from the drift pin to the 50-ton derrick, was selected with the predominating thought of safety first.

I believe it is also a matter of history that Post & McCord were the first contractors in New York City to use steam hoisting engines and compressors in the erection of steelwork, and were likewise the first to abandon steam when electricity had been proved a more desirable power for hoisting and air compression. The substitution of steel or wooden derricks was another forward step in which the firm was a pioneer. As a safety factor, however, I think the company's greatest achievement was through the introduction of wire rope slings for hoisting. For many years prior to 1912 the most serious accidents encountered were caused by the breaking of chains used in hoisting. Despite the closest inspection and most rigid care a chain would frequently break with disastrous results. Therefore, a substitute for chains was often the subject of grave discussion

among various engineers and members of the firm. Through these discussions the matter was finally brought to the attention of the John A. Roebling's Sons Co., the firm which, after exhaustive experimental work, developed the present day wire rope sling and enabled Post & McCord to be the first in New York to use this valuable factor of safety.

In this respect the firm makes no considering a wide margin of safety the best of insurance protection, a plain duty to the public in general and especially to the employes who have to entrust their lives to the proper performance of the equipment furnished.

Merely purchasing good equipment and putting it on the job does not mean efficiency or accident prevention. The first cost of the average tool or machine used for structural steel erection work is soon lost sight of in the items of upkeep and repairs. Therefore, eternal vigilance is almost as necessary in the inspection and care of the equipment as it is among the men.

At the storeroom of the company in Brooklyn a complete repair department is maintained. This outfit is in charge of men expert in repairing and overhauling the special machinery, tools and rigging used in erection work. These men are held responsible for the condition of all equipment sent to the various jobs and are therefore careful to have everything in good and safe working order before sending it out.

Co-operation Needed for Education of Employes.—As intimated in a previous paragraph, the firm has never actively pursued a scientifically organized program of safety work among the ironworkers. This is largely due to the fact that in the erection field the average job lasts less than six months or a year, and employes are constantly changing from one employer to another. Consequently, about the time one would have a safety movement ready to function the job would be finished, and on the next job he would have to start all over again with a new group of men. Therefore, it is the opinion of the firm that in order to make the theoretical feature of "safety first" a success among the rank and file of the men, movement would have to be made through a general headquarters composed of all employers within a certain district, and also through the headquarters of the various unions and organizations of the employes. In this way the message coming from an authoritative source, would reach all trades and cover all conditions involved.

Would not this work of "organizing the organizers" be a task well worth the attention of such a master Safety Force as the National Safety Council? I have read with marked attention of the wonderful success you have had in establishing the safety movement in various industries throughout the country, and hope that your Structural Department will in the near future be sufficiently strong to have so thoroughly imbued all the building trades, employers and employes with the spirit of Safety First, so that evidence of a careless accident can only be found in records of the past.

Physical Properties of Building Stone

The U. S. Bureau of Standards has continued its weathering tests on limestone and sandstone, although there have been some unavoidable interruptions during the past month. Several of the limestone specimens have passed 1,000 freezings without showing any appreciable signs of disintegration. The tests on sandstone were started at a later date, but some specimens have reached the 500 freezing with the samples of the better grades still in good condition.

A series of tests is in progress to determine the effectiveness of various stone preservatives. For this work specimens of limestone treated with various waterproofing materials are employed. These are alternately soaked in a 15 per cent solution of sodium chloride and dried at 104° F the crystallization of the salt giving an action similar to that of frost. A parallel series of treated specimens is being exposed to the weather and will be tested in the salt solution after periods of one and two years' exposure. In this way the preserving action of the treatments when first applied and also after they have been exposed to the weather for a considerable time will be determined.

Monthly Statistics of the Building Industry

The accompanying tabulations are taken from the Survey of Current Business, a publication of the U. S. Department of Commerce. They show (1) the building contracts awarded by thousands of square feet, and thousands of dollars, (2) the index numbers for building contracts awarded, (3) the building material price index for frame and brick houses, (4) the cost index for constructing factory buildings, and (5) the index numbers of wholesale prices for structural steel, iron and steel, composite steel and composite finished steel.

The figures on building contracts are based on data compiled by the F. W. Dodge Co., covering small towns and rural districts as well as large cities in 27 northeastern states. Prior to May, 1921, the building figures covered 25 northeastern states and the District of Columbia. The states are those north and east of, and including, North Dakota, South Dakota, Iowa, Missouri, Tennessee, and Virginia, together with portions of

	Grand Total Building Contracts		Index Numbers		Building Material Price Indexes		Cost Index	Wholesale Prices Index Numbers			
Year and Month	Thousands of sq. ft.	Thousands of dollars	Sq. ft.	Value	Frame house	Brick house	Factory building costs	Structural steel beams (Pittsburgh)	Iron and steel	Composite steel	Composite finished steel
1913 monthly av.	.....	$71,475	.....	33	100	100	.....	100	100	100	100
1914 monthly av.	.....	60,020	.....	28	.....	.....	100	92	87	88	86
1915 monthly av.	.....	78,841	.....	36	.....	.....	.....	93	94	95	92
1916 monthly av.	.....	113,082	.....	53	.....	.....	.....	177	154	163	161
1917 monthly av.	.....	184,086	.....	53	.....	.....	.....	269	266	259	252
1918 monthly av.	.....	140,770	.....	55	.....	.....	.....	202	215	220	213
1919 monthly av.	46,683	214,990	100	100	.....	.....	.....	174	191	193	188
1920 monthly av.	33,491	211,102	72	98	.....	.....	.....	187	249	211	222
1921 monthly av.	32,267	196,648	69	91	.....	.....	179	131	155	156	152
1922 monthly av.	47,745	279,410	102	130	182	186	170	115	144	134	134
1921											
January	15,513	111,608	33	52	.....	.....	.....	.....	.....	.....	.....
February	16,807	100,677	36	47	.....	.....	.....	.....	.....	.....	.....
March	26,709	164,092	57	76	.....	.....	.....	.....	.....	.....	.....
April	34,494	220,886	74	103	.....	.....	.....	.....	.....	.....	.....
May	35,751	242,094	77	113	.....	.....	176	146	165	170	166
June	35,738	227,711	77	106	.....	.....	172	146	159	165	159
July	31,717	212,491	68	99	.....	.....	167	139	145	153	148
August	35,246	220,721	76	103	.....	.....	161	123	137	144	141
September	41,702	246,186	89	115	.....	.....	160	123	134	138	136
October	40,486	222,480	87	103	.....	.....	157	116	135	134	134
November	37,318	192,311	81	89	168	173	154	106	132	133	128
December	35,272	198,518	76	92	173	179	153	99	129	130	127
1922											
January	30,261	166,820	65	77	174	179	152	99	127	126	124
February	30,061	177,473	64	83	169	174	152	99	125	124	121
March	51,957	293,637	111	137	169	173	152	96	125	122	122
April	53,146	353,162	125	164	168	172	152	99	131	126	125
May	59,639	362,590	128	169	173	176	157	106	139	127	127
June	60,526	343,440	130	160	178	181	159	106	140	129	130
July	51,705	350,081	111	163	181	184	171	109	142	130	131
August	54,019	322,007	116	150	189	193	174	116	151	137	138
September	44,275	271,493	95	126	193	197	190	137	166	146	146
October	46,806	253,137	100	118	196	199	192	141	166	149	148
November	46,946	244,366	101	114	196	201	192	136	160	149	146
December	38,608	215,213	83	100	192	198	192	132	154	149	147
1923											
January	38,947	217,333	83	101	195	199	192	132	158	151	149
February	41,611	229,938	89	107	198	201	197	135	162	158	157
March	64,920	333,518	139	155	209	209	197	146	171	165	163
April	64,527	357,475	138	166	206	209	204	172	179	174	169
May	60,430	374,400	128	174	212	214	208	174	180	176	168
June	46,344	323,559	99	150	212	215	206	169	175	176	168
July	42,021	274,224	90	128	214	217	206	166	172	176	167

eastern Kansas and Nebraska. Beginning May, 1921, North Carolina and South Carolina were added to the list, but this addition is stated to have little effect upon the total.

The price indexes for frame and brick houses are from the U. S. Department of Commerce, Bureau of Standards, Division of Building and Housing and Bureau of Census, and are based on prices paid for material by contractors in some 60 cities of the United States. The prices are weighted by the relative importance of each commodity in the construction of a 6-room house.

The index number for constructing factory buildings is furnished by Aberthaw Construction Co., and is designed to show the relative changes in the cost of constructing a standard concrete factory building. The company believes that the year 1914 gives a normal base and that July, 1920, with an index number of 265, represented the peak of costs.

The index numbers of wholesale prices for structural steel, etc., are obtained as follows: The prices for structural steel beams are the average of weekly prices from the U. S. Department of Labor, Bureau of Labor Statistics. The figures for iron and steel are the average of weekly prices compiled by the Iron Trade Review on the following 14 products: Pig iron, billets, slabs, sheet bars, wire rods, steel bars, plates, structural shapes, black galvanized and blue annealed sheets, tin plates, wire nails, and black pipe. Pig iron average in turn is average of 13 different quotations.

The figures for composite steel are compiled by the American Metal Market and represent the average price per pound of steel products weighted as follows: 2½ lb. bars, 1½ lb. plates, 1½ lb. shapes, 1½ lb. pipe, 1½ lb. wire nails, 1 lb. galvanized sheets, and ½ lb. tin plate.

The composite price of finished steel products is compiled by the Iron Age. It includes: Steel bars, beams, tank plates, plain wire, open-hearth rails, black pipe, and black sheets. These products, according to the Iron Age, constitute 88 per cent of the United States output of finished steel.

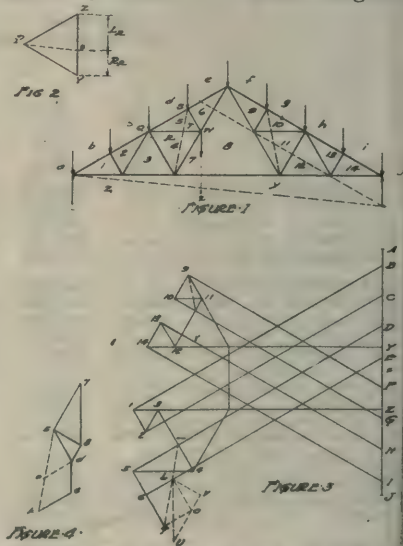
Solutions for Two Truss Problems

Stress Diagram for Truss with Interior Panel Load and Graphical Solution of Fink Truss Given in The Western Architect

By C. R. McANLIS

At times it is necessary to determine the stresses in the members of a truss when the truss carries an interior panel load. In Fig. 1, the load 7-8 applied at the point "W" is an example of the point in question. The load may be from a heavy driving shaft, hoist, or pipe line.

The stresses may be determined easily by means of a stress diagram.



Stress Diagram for Truss with an Interior Panel Load.

The first step is to determine the reactions. In Fig. 3, the load line A-J is laid off for the top chord loads, and as the loads are symmetrically placed with respect to the reactions, the reactions for these loads may be found by inspection. As each is one-half the total load, the top-chord left reaction is represented by the line X-A and the top chord right reaction by the line J-X. If the loads were unsymmetrically placed, these reactions could be determined by using an equilibrium polygon. The reactions due to the load 7-8 may be found analytically by means of moments or by employing the use of the pole polygon in Fig.

and the string polygon a-m-n in Fig. 1. The load polygon for the entire loading is laid off by beginning at "a" and plotting the top chords in order to "j". The reaction J-Y is equal to J-X plus X-Y which is the sum of the left reactions from the top chord loads and the interior load. This is represented on the load polygon by a vertical line upward from J to Y. Load Y-Z is plotted downward and the load polygon is closed by checking the value of the left reaction from "Z" to "A."

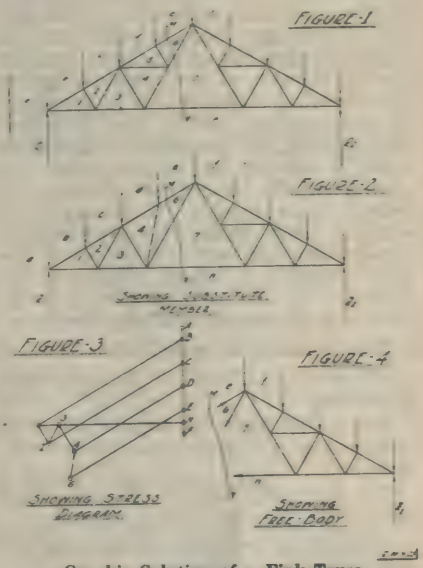
The stress diagram is begun at the left reaction and continued without any trouble until point "Q" is reached. Here the member R-T is substituted for the member 4-5 and point "R" is located.

At this point it is necessary to determine the stress in the member R-T. This is done by an indirect method. It is evident that the only stress that R-T can carry will be from the loads d-e and 7-8. The load 7-8 will be carried by 5-6 and the two straight line members 4-7 and 6-8, 5-6 carrying that part of the load 7-8 which is the component of 7-8 perpendicular to the member 4-7. In Fig. 4, this component is shown as 5-8 and the stress in member 5-6 due to 5-8 is represented by line 5-d. A force polygon, 5-d-e-K can now be drawn about point "S" which will give the stress 5-K in the substitute member R-T. This stress can now be plotted on scale in Fig. 3.

This construction can be carried out on Fig. 3 to the same scale as the stress diagram. Here R-L represents the component of d-e in the direction R-T, shown in figure 4 as P-K. If load 7-8 be laid off to scale as L-U, then L-V and L-O will represent 5-8 and 5-d in Fig. 4 and L-T will be equal to the stress in R-T due to load 7-8. T-6 can now be drawn and when point 6 is located the remainder of the stress diagram is an easy matter. Fig. 3 shows the complete stress diagram.

A Fink Truss Solution.—The writer has had so many students and men coaching for state examinations who have been unable to satisfy themselves with regard to the graphic solution of a Fink Truss that he is submitting an explanation of a simple example (which so far as he knows has never been published), with the hope that you may care to pass it on to any of your readers who may be interested in this line of work.

Figure 1 shows the form of the truss, and the construction of the stress diagram is a simple matter until Joint "A" is reached, where three unknowns are found. Members "4-5" and "5-6" are then taken out of the truss and one "substitute" member put in, in place of these two members, to transfer one component of the load "d-e" away from the upper chord. With this substitution the truss of Fig. 1 takes the form of Fig. 2, and



Graphic Solution of a Fink Truss.

the stress diagram is easily drawn as is shown in Fig. 3 (first half only drawn).

If each truss is cut by some plane "m-n" and a free body is made of the right portion of each truss as shown in Fig. 4, the form and external forces of the two free bodies are identical, and the respective members cut in each truss must have the same stress. The stress shown for "e-6" in Fig. 3, therefore, is the correct stress for "e-6" in the truss of Fig. 1 or the truss with the interior bracing. When point "6" is found in Fig. 3, it is certain that "e-6" represents in amount and direction the stress in member "e-6" in Fig. 1. With this known, it is a simple matter to continue the stress diagram and obtain the stress in members 5-6 and 4-5. With 4-5 known, the force polygon about point "A" can be drawn.

Water-Resistant Cold Press Blood Albumin Glue

A formula and method of preparation for a highly water-resistant cold press blood albumin glue developed at the U. S. Forest Products Laboratory, is given below. This glue does not require not pressing as do the older types of blood albumin glues, but is used in a cold press in the same manner as casein or vegetable glues. It can, however, be used in a hot press if the occasion demands. The improved glue can be used with success in the production of plywood and for gluing lumber of the species having low shearing strength, but in the stage of development which has produced the formula and preparation described here, it cannot be recommended for gluing thick veneer or lumber of heavy dense species. Further development may make the glue strong enough for use with all species. The glue shows a moisture resistance far superior to that of any glue in ordinary use at the time of its discovery.

The formula is as follows:

100 parts by weight of soluble blood albumin.

140 to 200 parts by weight of water (according to glue consistency desired).

5½ parts by weight of ammonium hydroxide (Sp. gr. 0.90).

15 parts by weight of trioxymethyleen (paraformaldehyde).

The blood albumin is covered with water and the mixture is allowed to stand for an hour or two. When it is stirred at the end of this period, the blood albumin will for the most part go into solution. The ammonium hydroxide is added with more stirring. Then the trioxymethylene is sifted in, and the mixture stirred constantly at a fairly high speed. The trioxymethylene should not be poured in so rapidly as to form lumps nor so slowly that the mixture will thicken before the required amount has been added. Regardless of the manner in which the trioxymethylene is added the mixture will thicken considerably at this point. This thickened mass will become fluid again in a short time at ordinary room temperature and arrive at a good working consistency in about an hour, remaining in this condition for at least 6 or 8 hours. When this glue finally hardens it cannot be dissolved again in water.

The glue may be applied by means of a brush or mechanical spreader.

Several precautions should be observed in mixing and applying this type of blood albumin glue:

1. Weigh out all constituents. Do not use volumetric measure.
2. Add water at room temperature and do not heat the mixture.
3. Do not stir the blood until it has soaked for from 1 to 2 hours.
4. Avoid excessive stirring of the glue or agitation of the spreader, as this causes foamy glue.
5. Use sufficient pressure to insure good contact but not enough to crush the wood.

The fact that cold press blood albumin glue will solidify under water indicates that the "setting" of this glue is a chemical reaction and not a result of evaporation.

Durability of Various Kinds of Building Stone in Service

In order to obtain information on the durability of various kinds of building stone in actual service, an inspection trip was recently made by a number of the U. S. Bureau of Standards' staff covering 7 cities. About 200 masonry buildings were examined, which illustrate the use of approximately 40 different building stones. As far as possible the dates of construction were ascertained and the stone identified. A few cases of stone decay were found in quite recently constructed buildings. This appeared to be due principally to a recrystallization of soluble materials which had been leached out of the mass of the stone work or the mortar and deposited as an efflorescence in certain places at or slightly beneath the surface of the stone. This phenomenon occurs frequently under the water table and under the cornice. It has been noted on structures of different types of stone, but most frequently on those of sandstone. It has been duplicated in the laboratory by placing blocks of stone partly immersed in a weak solution of sodium sulphate. The salt is carried up in solution through the pores in the stone by capillarity, and is deposited in crystals on or slightly beneath the surface wherever evaporation occurs. These crystals expand in forming and cause disintegration of the stone in a manner similar to that of frost but at a much faster rate.

Equipment Review

QUARTERLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.
221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*
LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 904 Longacre Bldg., 42d St. and Broadway
RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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Vol. LX. CHICAGO, ILL., OCTOBER 31, 1923 No. 2

Equipment and the Contractor

While the best tools in the world will not save a bungler, the lack of proper equipment will damage even the most skilled operator—the degree of damage extending all the way from a moderate reduction of profits under favorable circumstances, to complete ruin where other conditions are bad. Particularly is this true in all competitive fields.

The contractor's economic problem of equipment is a complicated one, and the pros and cons which he must consider before purchasing any important piece of equipment can not be listed in detail here.

There are mathematical formulas developed in the 'Handbook of Cost Data" by Halbert P. Gillette, editor in chief of this paper, by which one can determine to a nicety whether or not it is economic to purchase a given machine or to replace an old machine by a new one—provided all the data of the case are available. When, as most often happens, some of the data are lacking, the usefulness of the formulas is affected in varying degrees. Often in a special problem some of the factors of a complete solution are so small as to be of no consequence, and an entirely satisfactory result can be obtained without them. In other cases, where the absence of more important data makes a completely dependable solution impossible, the formulas still frequently will serve as valuable guides to judgment. We suspect that it is upon the basis of these or similar formulas that Henry Ford makes his famous decisions on the scrapping of old machines as soon as new ones can be found to do their work cheaper.

Like Mr. Ford, the contractor is depending more and more upon equipment for his profits; but his information on new equipment comes of necessity chiefly from his professional journals, and the quarterly editions of Engineering and Contracting are therefore especially designed to serve him this purpose.

Recent Developments in Construction and Engineering Equipment

All-Steel Blast Hole Drill

The tendency today in quarrying and heavy rock excavation work, seems to be more and more toward the use of machines and equipment made entirely of iron and steel. The modern quarryman wants machinery that has strength and stability—something that will stand up and give continuous economical service. Among the late advancements made along this line is the Armstrong all-steel blast hole drill, which was recently placed on the market by the Armstrong Manufacturing Co., Waterloo, Ia. This machine is claimed to possess many exclusive features of design, construction and operation, with a simplicity of working parts that assures continuous operation with a minimum of repair and maintenance expense. The derrick is provided with the Armstrong patented device for using steel drilling cable in place of hawser laid manila, which feature is stated to insure a saving of at least 75 per cent in cable costs alone to the operator. Both traction and non-traction models are built to be operated either with gasoline or electric power. The gasoline engine furnished is of the 4 cylinder heavy duty type, which supplies a steady flow of economical and uniform power under all conditions.

New Armstrong All-Steel Blast Hole Drill.

Offset Hitch for Tractor Use

Conforming to the growing demand for motorized grading outfits, the Western Wheeled Scraper Company, Aurora, Ill., has developed offset hitches for all standard Western grading tools for attachment to the low drawbar of a small tractor. Contractors, road officials and others who own such tractors will be able to increase their value and service by installing grading tools which have been adapted to tractor use.

The illustration shows the offset hitch designed for a standard Western wheeled scraper. Its strength and practicability will be at once recognized. An ordinary wheeled scraper with stub pole cannot be used with some of the most popular types of tractors. The drawbar of the small tractor is only about 12 in. from the ground, so low that the pan of loaded scraper would catch and overturn while in transit. The offset hitch remedies this condition and carries the bottom of the pan in the same place as when used with teams in the ordinary way.

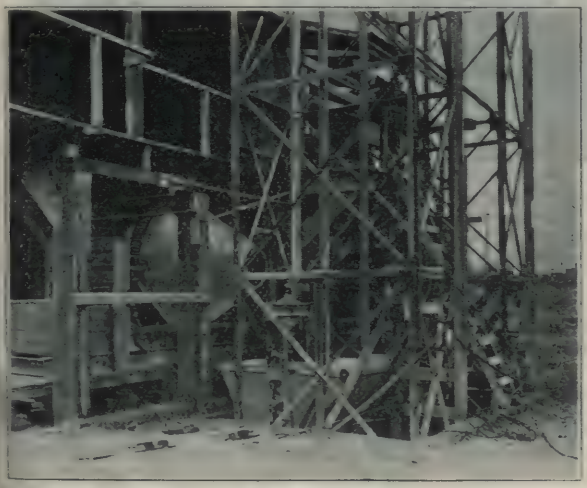
Western Wheeled Scraper with Offset Hitch.

Electrically Operated Central Mixing Plant

An electrically operated central mixing plant is an important feature of the construction operations of the Jones Island sewage disposal plant of Milwaukee, Wis. The job will require about 69,000 cu. yd. of concrete and it is expected it will be completed about Dec. 1.

The concrete is being mixed in two electrically driven Smith 40-S tilting mixers. These two mixers, each with a batch capacity of 1½ yd. and with batch hoppers, water tank and batch meter, are situated as the central units in the large mixing plant maintained on one of the long sides of the job. Extending in radial lines from this central mixing plant, chutes carry the concrete to all parts of the work, having outside dimensions of 650x750 ft., with the highest point of concrete averaging 20 ft., gives some idea of the speedy and steady output required from the two mixers.

Construction View of Jones Island Sewage Disposal Plant, Milwaukee, Wis.



The Mixers.

In addition to the two Smith 40-S tilting mixers, the central mixing plant includes two Insley steel hoisting towers, 1½ yd. capacity and 216 ft. high, so arranged that power is supplied to both hoists by one 100 h.p. double drum, Thomas electric hoist. The aggregate is fed into the mixers from two overhead bins, each about 100 yd. capacity, these bins being fed by two 100-yd.-per-hour capacity bucket chain elevators. These, in turn, are fed by automatic chain belt feeders. The entire bin feeding apparatus is electrically driven. When available, bottom dump cars deliver the sand and gravel direct to the bottom of the bins. When other cars are used, a 1-yd. clamshell derrick unloads the cars—this derrick also being used in handling the material for the 1,000-yd. stock pile which is maintained.

A cement bin of about 2-car capacity is located close to the bins, this being used for emergency storage

only. A gravity trolley system, with cement containers of the bottom dump type, each about 8 bags capacity, is constantly dispatching the cement to the mixers direct from the cement cars as they arrive.

From the mixing plant the concrete is conveyed to the various parts of the job by a series of hoisting towers and several lines of chutes. The two main towers at the mixing plant, supply one line of chutes 450 ft. long to an Insley re-hoist tower 196 ft. high. This re-hoist tower in turn supplies a 120 ft. tower, placed in the center of the job, which supports a line of chutes 280 ft. in length on each side of the tower, with a 50 ft. counterweight chute on each end which is used to pour the circular tanks in the center of the job.

An Insley guy derrick of 10-ton capacity, with 115-ft. mast and 100-ft. boom, which supports a double counterweight chute system with total operating radius of 170 ft., is being placed in four different working setups, and is supplied with concrete either direct from the two main hoist towers or from the re-hoist tower.

Williamsport cable is used throughout the job, the main suspension cable being 1½ in. in diameter, the rest being 1¼ in. or 1⅛ in.

The two Smith tilting mixers are being operated alternately, and with specifications calling for 1½ minute mix are stated to have reached a maximum of 600 yd. per day in one continuous pouring. The average per day, however, during the length of the job has been 400 yd.

The job which will cost well over $750,000 is being directed by the Du Pont Engineering Co., Wilmington, Del.

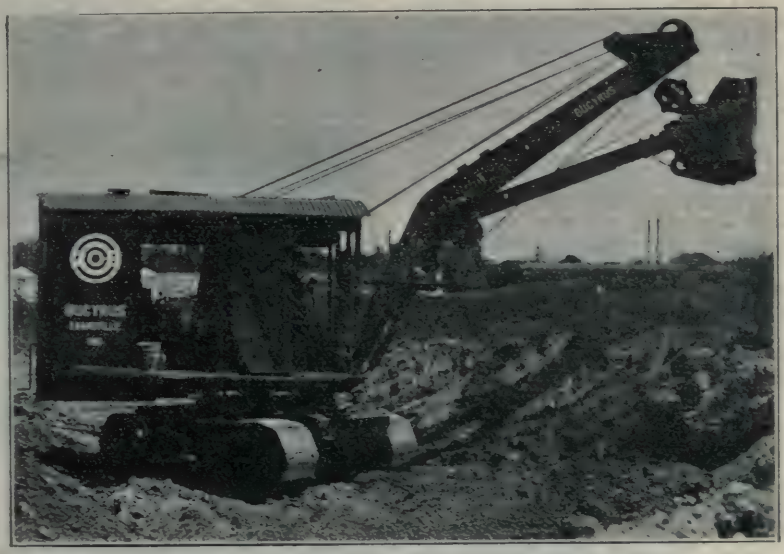
Method of Cooling Ford Engine for Mixer Operation

The accompanying illustration shows the Archer 1-bag mixer of the Archer Iron Works, Chicago, on its Ford Model T chassis mounting, engaged on a construction job at Chicago. Of particular interest in the view is a simple method shown for keeping the Ford engine cool while operating the mixer. Without some cooling device, the Ford engine will not work satisfactorily when standing still for industrial work. A hose connection is run from the water supply into the mixer to the top of the Ford radiator. The overflow pipe in the Ford radiator is blocked off and when the tank is full of water the capacity of the Ford radiator has been increased by 15 additional gal. of water. With this method of cooling, the engine works very satisfactorily and will not heat up.

Simple Method of Cooling Ford Engine

A New ¾ Yd. Gasoline Shovel

There is no question but what the demand for excavating machinery operated by internal combustion engines has been on a very rapid increase of late. In response to this demand the Bucyrus Company of South Milwaukee, Wis. a year or so ago brought out a new 30-B 1-yd. gasoline shovel and dragline. They are now prepared to offer a ¾-yd. machine of the same type. In these two shovels the well known Bucyrus standard of building a machine has been maintained. It is stated that these machines are not what are called "fair weather" machines, but will perform satisfactorily in all materials that they may be brought up against. Mechanically, the principal feature of prominence is the fact that they both have what is called a rope-thrust on which basic patents are held by the Bucyrus Co. This thrust is even more powerful than that which is accomplished by the independent engine on the steam machine. The simplicity of this design is one of its most desirable features. A glance at the accompanying photograph will show that there is no engine, no complicated shafting, no chains or bolts on the boom. This drive consists of a small drum on a shaft to which are keyed the thrusting pinions which engage with the racks on the dipper handle. This boom is turned one way or the other by ropes which lead back to drums in the main machinery. The 20-B shovel may also be had with a high-lift or extra high lift boom. Its operating ranges are approximately the same as of the steam machine of the same size. It also may be had as a dragline excavator, clamshell machine, or a crane.



Bucyrus 20-B High Lift Gasoline Shovel—26 ft. Boom, 15 ft. Handle, ¾ yd. Bucket.

Rail Filler for Street Railway Track

A rail filler of tempered asphaltic compound reinforced with asphalt saturated felt is a recent product of the Philip Carey Co., Cincinnati, O. The foller is pre-formed to shape to fit any type of rail, and is made in 3 to 5 ft. lengths for easy handling. It is quickly cut to shorter lengths with an axe where fitting is necessary. In installing the filler is tapped into the rail with a mallet, and the concrete, brick, granite block, or other paving material laid to it. It is easily installed on curves and frogs. The purpose of the filler is to provide a resilient cushion between the rail and the road material, and to absorb rail vibration, and expansion stresses due to temperature changes; also to exclude rain and frost, protecting the street and track from these destructive forces. It is also stated to be a valuable electrical insulator.

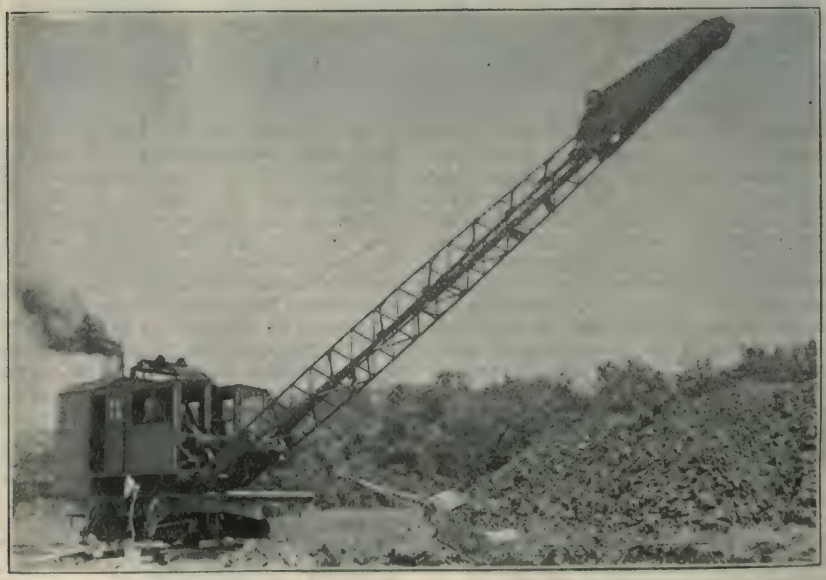
Locomotive Crane

The accompanying illustration shows the 20-ton, 8-wheel locomotive crane brought out recently by the McMyler Interstate Co., Cleveland, O. In this crane simplicity in operation and ease of control are gained through the use of large friction clutches for all functions, in conjunction with a non-reversing engine. This permits any or all functions to be performed simultaneously. The crane will handle a fall block, two line bucket, lifting magnet, drag line bucket or pile driving attachment. It has sufficient tractive effort to shift several loaded cars. With its maximum single line load of 10,000 lbs., the normal hoisting speed is 300 ft. per min. The line pull available for rapid bucket work is 7,500 lb. At 12 ft. radius, with a 40-ft. boom, the crane has sufficient stability to lift 45,000 lb. In designing the crane, full appreciation has been given to the desirability of having all parts of the mechanism readily accessible for adjustment and repair. Practically any shaft may be removed by simply taking off the two bearing caps and without disturbing any of the other mechanism. Replaceable bushings are used in all bearings. All the gears are steel, those above the turntable having cut teeth. The boom hoist mechanism will raise and lower the boom with maximum load specified at various radii.

Motor Truck Snow Plow

The 1923 model of the auto truck snow plow of the Baker Manufacturing Co., 506 Stanford Ave., Springfield, Ill., shows some important new features. This snow plow is made for attachment to the front axle of standard motor trucks without the necessity of drilling any holes in the truck.

Baker Auto Truck Snow Plow.



McMyler-Interstate 20-Ton Crane

There are adjustments which allow for different widths between spring centers of truck, height of truck and position of seat. One of the outstanding features, is the patent safety tripping blades hinged to the moldboard or plow proper, which trip back when obstructions are encountered, such as man-holes, crossings, etc. The blades are made of cast steel in 2 ft. sections 6 in. wide so that only that section of the plow which strikes the obstruction is affected, thus allowing only a small portion of the snow to leak through.

Pressure Type Water Filters

The vertical pressure type of water filter made by the Graver Corporation, East Chicago, Ind., is illustrated. In these filters the water to be filtered enters the tee at the center of the vertical pipe and passes upwardly through a valve into the shell of the filter near its top. The water is distributed about the top of the filter chamber without eddies by means of a large up-turned diffusing funnel and passes downward through the filtering medium to the perforated pipe manifold or strainer system. In washing the filter to remove the accumulated suspended matter the water is forced under pressure into the manifold piping and through the strainers, upwardly through the filtering material, overflowing the surface of the bed and then is conducted off to waste through the top over-flow funnel. The method of wash is the so-called "high velocity" or high water rate method, no other means of agitation being necessary. Under some circumstances, such as in filtering chemically treated softened waters it has been found advisable to supplement the "water wash" by a prelimary "air wash." In this case air is injected into the filter through a second system or perforated manifold piping placed in the gravel above the strainer system. The air forced under a pressure of about 3 to 5 lb. per sq. in. rises above its point of liberation and increases the amount of agitation in the filter bed so that the different particles of quartz rub against each other sufficiently to loosen any matter such as lime or magnesia adhering to them. About 3 cu. ft. of free air per minute per sq. ft. of filter area is quantity generally specified.

Battery of Two Filter Units.

Centrifugal Pumping Outfit

A centrifugal pumping outfit designed particularly for gravel washings, irrigating, drainage work, quarry pumping, draining clay pit in brick plant, etc., is illustrated. The pump is of the open impeller type and will handle free flowing water carrying sand and grit in suspension without clogging. The pump casing, or shell, is solid and very handy. The

inside of the pump casing is machine finished and the runner is accurately fitted. The 4-cylinder heavy duty truck type engine is equipped with

Barnes Centrifugal Pumping Outfit.

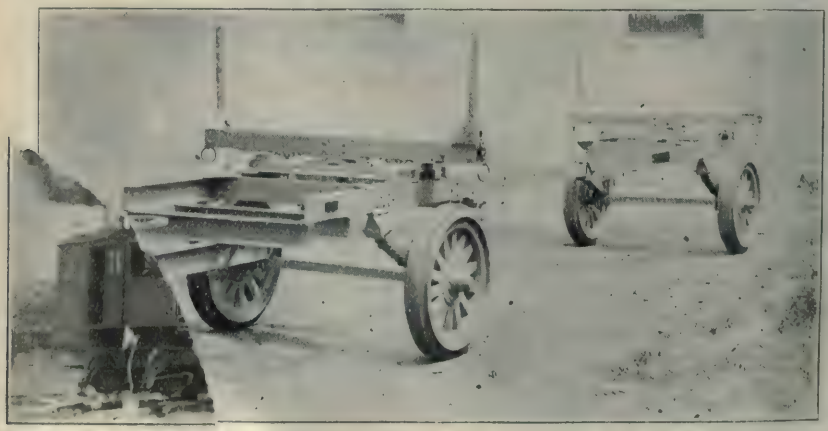
high tension magneto and float feed carburetor. A radiator and fan cooling system is regular equipment; the muddy water which this outfit will handle is not practical for engine cooling. A flexible coupling connects the pump and engine. A large oil ring bearing supports the pump shaft and relieves the engine of all strain. The outfit is entirely self contained and ready to run. It is made by the Barnes Manufacturing Co., Mansfield, O.

Trailer for Transporting Long Loads

A 5-ton trailer designed for use with a Fordson in transporting long poles, logs, lumber, pipe, heavy oil castings, etc., is illustrated. The frame is 5 in. channel iron, hot riveted and well reinforced with cross members and heavy gusset plates. The bolsters are of the swivel type, 70 in. long. A special cast steel hitch is used for attaching the second unit to the first. The coupling pole is adjustable to various length loads. The minimum distance between bolsters is 10 ft. and the maximum distance is 18 ft. With a 3½ ft. overhang at each boltster, a load 25 ft. long can be handled. This trailer is made by the Miami Trailer Co., Troy, O.

New Rotator Drills

The popularity of the one-man self rotating hammer drill has caused its adoption in a rapidly increasing variety of drilling work. It is now used for not only light drilling, such as block-holing, to break boulders; cutting trenches in road construction, etc., but is also widely employed for shaft sinking, for drilling deep holes, sometimes as much as 20 ft. or more in depth, in quarries, and for light drifting and tunneling. For this work it is often mounted on a tripod or column with a special cradle shell and feed screw mounting, or this can be applied to quarry bar work if desired. The Sullivan Machinery Co., Chicago, Ill., has recently placed in the field its new line of DP-331 Rotators, for which it claims a considerable increase in drilling speed, coupled with low air consumption per unit of drilling, no increase in weight, and low repair cost. The freedom from vibration of these tools is also noteworthy. These



Miami Fordson 5-Ton Trailer.

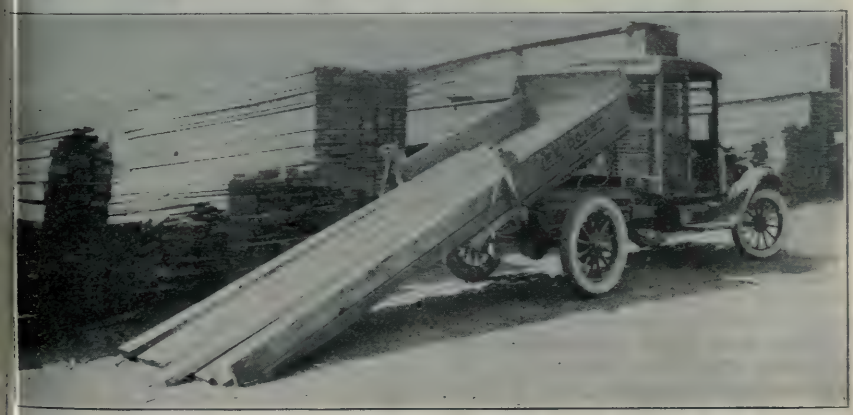
ew rotators are built in the following models: "DP-331," with either olid or hollow piston, with air tube ypass and with water tube for injecting water through the steel. A steam

Air Tube Model Sullivan Rotator DP-331.

ube drill is also manufactured. These types range from 38 to 40 lb. in eight. "DP-321" Light Rotator, eight 29 lb. Available in solid and hollow piston and water tube types. "DR-371" Auger Rotator for soft and broken ground, uses either the standard ⅞ hexagonal hollow drill steel, or solid twisted steel with fishtail bit. Available in either solid or hollow piston type. Weight 35 lb. A feature of these machines is the fact that an adaptation of the interchangeable part system permits customers having rotators in use in the field to obtain the newer advantages claimed for these models by the purchase of a relatively small number of parts to substitute for the corresponding parts in their old drills. The purchase of entire new machines is thus avoided in many cases, while the benefits of increased drilling speed, etc., are secured.

Dump Body for Hauling Lumber

In construction work there is often as much lumber to be hauled around and to and from the job as there is sand and gravel. Hauling lumber in a dump body is nothing new. To do so successfully, however, it is desirable that the body be equipped with a double-acting end gate both for the purpose of holding a larger load if necessary and also to provide an additional floor area in the body so that longer lengths can be carried. If loaded properly lumber is just as easily dumped out of an automatic dump body as any other kind of material, as shown in the illustration. The Indiana Harbor Lumber & Coal Co., which does a lot of hauling for road and building contractors, has gone a step further and is operating a body built in such a way that extra long lengths of timber and plank can be handled successfully. This consists of a dump body provided not only with a double-acting tailgate at the rear, but a single-acting tailgate also at the front end. The body recently

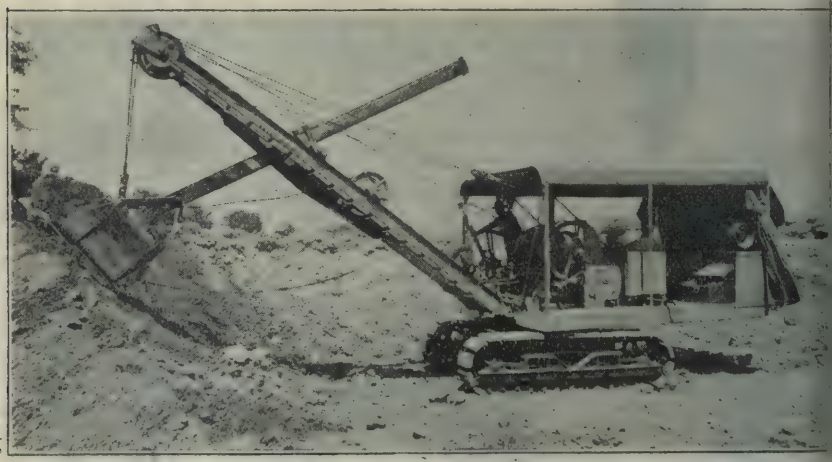


Automatic Dump Body Used by Indiana Harbor Lumber & Coal Co. in Hauling Lumber.

put into operation by the Indiana Harbor Lumber & Coal Co. is an automatic dump body built by the Lee Trailer & Body Co., Chicago, and has no obstructions such as a hoist or anything of that kind between the cab and the front end of the body, therefore the load can be shoved up flush against the cab, and in the case of very long lengths can be loaded in the extreme sides of the body so as to extend alongside of the cab.

The Michigan Shovel

A sturdy shovel built by the Michigan Dredge Co., Bay City, Mich., is illustrated. This is a full circle swing, continuous tread, and gasoline operated machine. The shovel contains some unique features. The steering and tread are very simple and can be operated in any position of the upper turntable base. The dipper crowding arrangement is powerful and the striking facts about this shovel is the ease with which the operator can control and place dipper, even to shake it to relieve it of sticky materials. The shovel is driven by a heavy duty engine and the drive from engine to machinery is by a heavy duty silent drive chain. All control levers are in front, on the right side of machine. The frame is made up of structural steel shapes well fitted together and securely riveted.



The Michigan Shovel.

Improved Grader Wheels

The Stockland Road Machinery Co. Minneapolis, Minn., has recently made an improvement in its Master, Standard and Special graders, using a heavier wheel with a heavy cast iron hub The wheels in the medium sized machines have steel tires and stee spokes. Spokes are set in the tire i a countersunk drilled hole and shoulder is formed on the spoke in side the tire. The spoke is thus per manently set in the tire, with the hea to keep it from pulling out and th shoulder to prevent its pushin through. At the hub end of the spok the same style of attachment is use The spoke can neither push in nor pu out. In the larger and smaller m chines a pressed steel hub is used. the medium sized machines—Stan ard, Master, Special—the hub is high-grade cast steel. These two d ferent types of hub are provided to the wheels to the particular type work each machine must do. The h construction of the wheel is design to lengthen the life of the wheel the use of removable box to take the wear, and to lengthen the life the axle. In the cast steel hub t hub box is held securely in place rigid bolts. It positively cannot tu inside the hub.

General Purpose Small Crane for Railroad Service

A general purpose utility crane is now being produced by the Orton & Steinbrenner Co. to meet the demand for a small outfit as used in railroad yards. It is designed for mounting on a flat car, traveling the length of the car, revolving in a full circle, and yet keeping within all railroad clearances. The length of the boom is 28 ft., which enables it to be shipped anywhere on a 40 ft. car. The crane is equipped to handle with equal facility, hook, bucket or magnet. The maximum capacity is 7 tons at 12 ft. radius; or it will handle a ½ or ¾ yd. bucket with the boom extended to 28 ft. radius, or a 36 in. electro magnet handling a length of 130 lb. rail, weighing 1,430 lb., at the maximum radius. The wheels are spaced 6 ft. 6 in. centers, thus giving a wide base for stability. The boom measures 28 ft. center to center, thus providing long enough reach to unload rails from a car in front or in back of the crane car, on the same track, and also on adjacent tracks. The power is furnished by a 4-cylinder 5 in. by 6½ in. heavy duty gasoline motor, with high tension magneto. This motor is geared directly to the hoisting, swinging and traveling gears. It is operated by one man only. A generating set, belt connected to the engine, furnishes current for a 36 in. electro magnet. This device is of great benefit in handling magnetic materials such as rails, switches, frogs, truck side frames, wheels, etc. The magnet will pick up a length of 130 lb. rail at the maximum radius. Bucket handling drums are also furnished on the machine. A ¾ cu. yd. bucket will handle on an average ½ ton of coal per trip, and at a rate of two trips per minute, the machine will handle about 30 tons of coal per hour. As an emergency locomotive coaler, it is thus available for clearing the track, and removal of snow for the right of way, the bucket also comes in handy. With a fall block and hook, the crane can lift as much as 14,000 lb. at 12 ft. radius with correspondingly less capacity at longer radii. At the maximum radius, that is, 30 ft. from the center of the machine, it can handle 4,400 lb. A separate shaft with two niggerheads is supplied on the front of the crane.

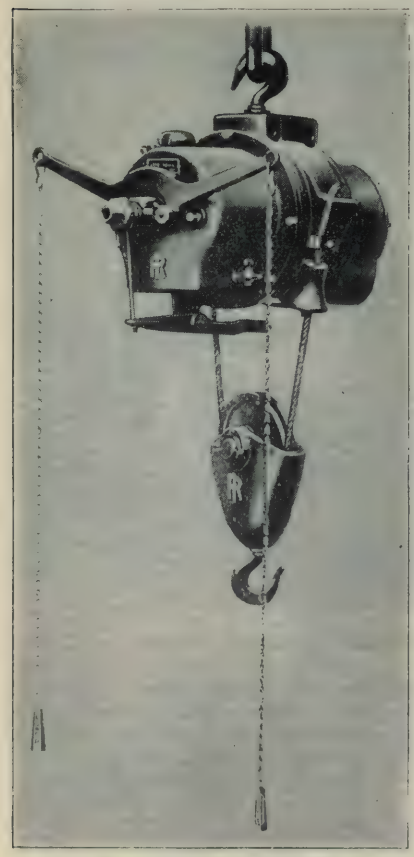
Crane Handling Clam Shell for Coaling Locomotive.

These are useful in pulling cars and dragging in loads to a position where they can be handled on the boom. The novel feature of the crane, of course, is its movability, that is, it can be shifted anywhere in the division on its own car, and is always ready for service without any preliminary firing, nor is any trouble encountered from bad water or lack of ready coal supply.

This crane is made by the Orton & Steinbrenner Co., 608 S. Dearborn St., Chicago.

New Air Motor Hoists

A new small air motor hoist containing many novel features has been



Front View of Ingersoll-Rand Air Motor Hoist.

brought out by the Ingersoll-Rand Co., 11 Broadway, New York. The outstanding characteristics of the new hoist are briefly as follows: Compactness of design resulting in low head room required; and relatively light weight; automatic brake which positively holds the load under all circumstances—even if the air supply be disconnected or fail; and a graduated throttle which permits a very close regulation of both the lifting and the lowering speeds. A balanced three cylinder air motor is used which operates in either direction and without vibration at any speed or load within the rated capacity of the machine. The motor is of the same reliable type such as has long been provided for Ingersoll-Rand hoists. The throttle graduation on this new hoist is very fine and this ensures instant and complete control of the hoist at any speed and contributes to the excellent operating performance. A safety stop lever is provided which closes the throttle and stops the motor whenever the load is by chance raised to the top of the hoist lift. The automatic brake is a new and valuable feature as it holds the load at any desired position for any length of time regardless of air pressure. The brake consists of a disc attached to the motor shaft, and of a brake plunger with a friction face which is held in contact with the disc by springs whenever the hoist is not operating, i. e., whenever the air supply to the motor is cut off either by throttling or otherwise. It is entirely automatic in its action and requires no attention from the operator. The essential details of the hoists are as follows:

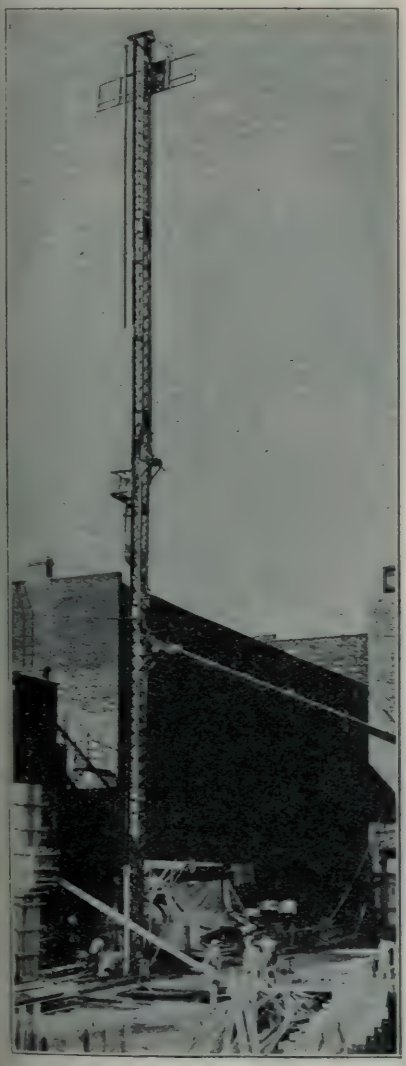
Capacity (lb.)	50
Feet lift per min. (80 lb. air pressure)	[illegible]
Max. lift feet	[illegible]
Size and length Wire Rope	¼ in. x 35 ft.
Net Weight, lb.	1[illegible]

Construction in September

The decline in construction volume which began in June continued through September, according to F. W. Dodge Corporation. However the September drop from August was only 3 per cent. Total September building contracts in the 36 Eastern States (including about ⅞ of the total construction volume of the country) amounted to $288,931,700. In the 2[illegible] states for which records were kept last year the drop from September 192[illegible] was 7 per cent.

New Mast Hoist Bucket Plant

A recent development in the field of concrete placing machinery is a mast hoist bucket plant, involving the use of a steel mast, made by the Insley

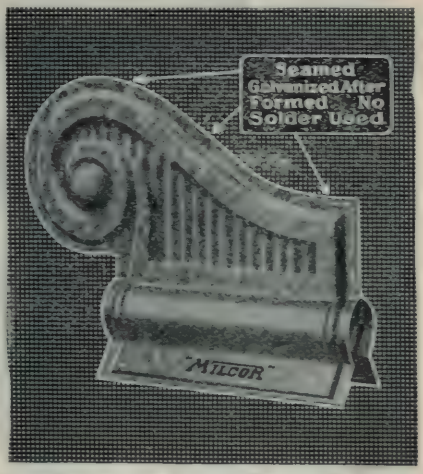


New Mast Boom Plant in Use on Underwriter Laboratory Job of H. F. Friestedt, Contractor, Chicago.

Manufacturing Co. of Indianapolis. This plant consists of a steel mast upon which a hoisting bucket, head frame and chute system are mounted. The mast is made in 20 ft. interchangeable sections, and is designed for a total height of 140 ft. The bucket is made in two sizes to take the output of a 1 and 2-bag mixer. The dumping operation of the bucket is automatic, the bucket dumping itself upon striking the head frame. The new feature of the plant is the use of the steel mast to support the first section of chute. The upper end of the chute is seated on a bracket and the lower end supported by a line which is connected to a bridle on the face of the mast. This bridle and bracket are connected to make a sliding frame which can be easily moved up and down the face of the mast, thus changing the elevation of the chute line without changing the fixed relation of the bridle, bracket and chute. In effect, the first 30 ft. section of chute is a boom, and supports the upper end of the second section of chute, thus giving a free pouring radius of 60 ft. from the face of the mast. The whole plant makes available on a smaller scale many of the advantages incorporated in the quick shift steel tower plants of the same manufacturer. It is designed to meet a wider field than it was thought could be reached by means of the wood mast hoist plant.

A New Gable Finial

Too often the all-important gable ends of houses are left bare and unfinished and are out of harmony with the surroundings. Proper gable finials



No. 915 Gable Block Finial.

will set off the gables in bold relief and impart a detailed, finished appearance, in keeping with the premises.

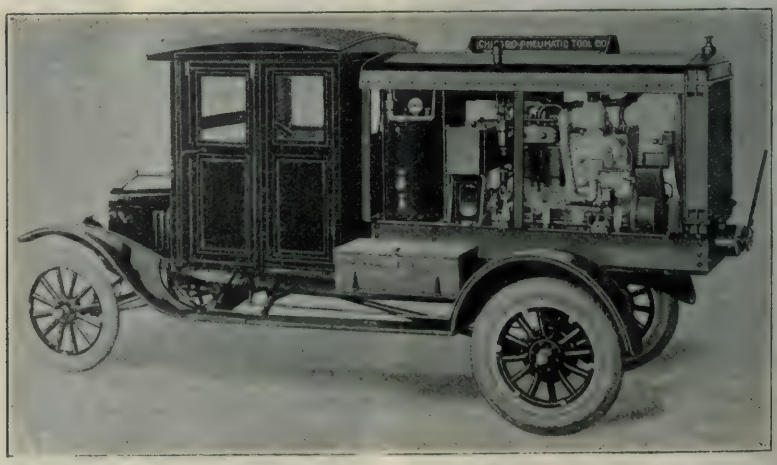
The Milwaukee Corrugating Co., Milwaukee, Wis., has designed a new gable block finial called the No. 915 Gable Finial, that is of particular interest. The finial is practically one piece and is formed by a special process from the best copper-bearing terne plate. The seams are carefully lapped,

Gable Block Finial in Place.

thus giving it unusual strength and rigidity. It is galvanized both inside and out after formation, so as to give it the longest possible life, and has the additional advantage in that it can be used with 1¼ in., 1½ in., and 2 in. ridge roll. Prominent among the many characteristics of the No. 915 finial are beauty and distinctiveness. The details are carefully formed, the design carries deep and is very pronounced.

Air Compressor Mounted on Ford Truck

A line of gasoline driven air compressors mounted on 1-Ton Ford trucks has been brought out by the Chicago Pneumatic Tool Co., 6 East 44th St., New York City. These compressors are built in two sizes—66 cu. ft. and 95 cu. ft. capacity. Owing to their portability these compressors can be carried close to the job and the loss in air lines is thus reduced to a minimum, avoiding the necessity for a larger compressor. By mounting two air cylinders and two power cylinders on the same sub-base and by using one crankshaft for the four cylinders, a unit of great compactness was secured. The compressor has the well known ring plate type of air valves, known as the "Simplate Valves," and it also has the pressure system of lubrication. A unique governing system, the "Auto-Pneumatic Throttle," regulates the supply of air by controlling the speed of the engine so that when the demand for air ceases or slackens greatly the engine immediately slows down to the lowest speed at which it will turn over—the compressor being unloaded in the meantime by means of the differential unloader—so that the least possible amount of fuel is consumed. Cooling of the engine and compressor is effected by means of a radiator of ample capacity and a large fan. Water is circulated by a centrifugal pump built into the engine. Large roomy tool boxes are placed on each side of the compressor base. The whole machine is covered with a sheet metal top, and sides of the same material are used to enclose and protect it from the weather when not in use. This same type of compressor is also mounted on rubber tired trailers, steel wheel trucks and on skids.



Chicago Pneumatic Class P2-DGL Air Compressor Mounted on Ford Truck.

Convertible Crawler Crane

The 10-ton steam operated convertible crawler crane of the McMyler-Interstate Co., Cleveland, O., is illustrated below. The crane is fitted with the necessary mechanism for performing the operations of hoisting on either of the two main drums, or of operating a two-line bucket. The mechanism is also capable of lowering and raising the boom, rotating the crane and traveling. It is arranged for attachments to operate a drag line bucket, to operate a magnet, to drive light sheet piling, and to operate a shovel.

McMyler-Interstate Convertible Crawler Crane.

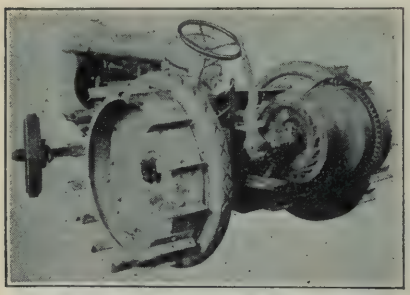
The various operations of the crane is actuated by a double cylinder, non-reversing steam engine. Link motions and reversing valves are eliminated through the use of right and left hand clutches for raising and lowering the boom, for sluing and for propelling. A single lever controls each pair of clutches so that each operation in either direction is controlled by one lever only. The normal hoisting speed, single line full load is 200 ft. per minute. The single line pull, bucket work is 6,000 lb., and the maximum single line pull is 10,000 lb. The over all length of the crane is 16 ft. 7 in., and over all width is 8 ft. 10 in.

An Improvement in Steel Tower Construction

An improvement in steel concreting tower construction that is causing favorable comment among engineers and contractors has been made recently by the Ransome Concrete Machinery Co., Dunellen, N. J. In place of the usual "Z" bar section for the front posts Ransome has adopted a riveted channel and angle construction which, it is stated, greatly increases the strength and rigidity of the tower without adding to the weight. It is claimed that this construction is 61 per cent stronger than a "Z" bar section of the same weight per foot. Slide panels are bull riveted in the factory leaving only front and back panels to be bolted in the field. All panels are cross braced. The cross bracing in the front panels is made up of two angles back to back and the horizontal bracing in all panels of two angles in "star" position. The construction of the sliding frames makes the tower as strong at the panel through which the bucket dumps as though the bracing had not been taken out.

Hoist Attachment for Fordson Tractor

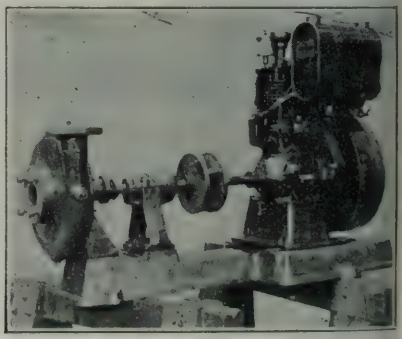
A Fordson tractor hoist attachment is now a standard addition to the line of the Clyde Iron Works, Duluth, Minn. It consists of a friction drum supported in a cast steel frame fastened to the tractor by eight of the bolts which connect the rear axle housing and the transmission housing and two bolts through the two outside holes in the drawbar cap just below the operator's seat. The frame is so designed that no drilling or tapping or machine work of any sort is required for assembling on the tractor. The drum is 8 in. diameter, 10 in. long between flanges with 18 in. diameter flanges. It is friction driven, having Clyde standard wood cone frictions and thrust mechanism, has long bronze bushings with grease cup lubrication and is equipped with a foot-lever-operated asbestos-lined band brake and ratchet with pawl. The hoist attachment is so mounted that the drawbar can be used for hauling without removing any part of the hoist. The gearing is of steel with machine cut teeth. Power is supplied through a roller chain drive and sprockets from the pulley shaft of the Fordson. A rod placed on the lever side of the drum gives the operator full control of the throttle from his regular position. All shaft bearings are babbitted and lubricated with grease cups, the drum shaft bearings being equipped with removable caps. The attachment has a width over bearings of 24½ in. The drum has a hoisting capacity of from 2,500 lb. to 3,960 lb. on a single line at speeds of from 225 ft. per minute to 142 ft. per minute, respectively, depending on the amount of cable on the drum. The drum will hold approximately 400 ft. of ½ in. cable. The winches are mounted on timber skids for shipment. The approximate shipping weight is 600 ft. including the tool box.



Clyde Hoist Attachment for Fordsons.

New Centrifugal Pump Unit

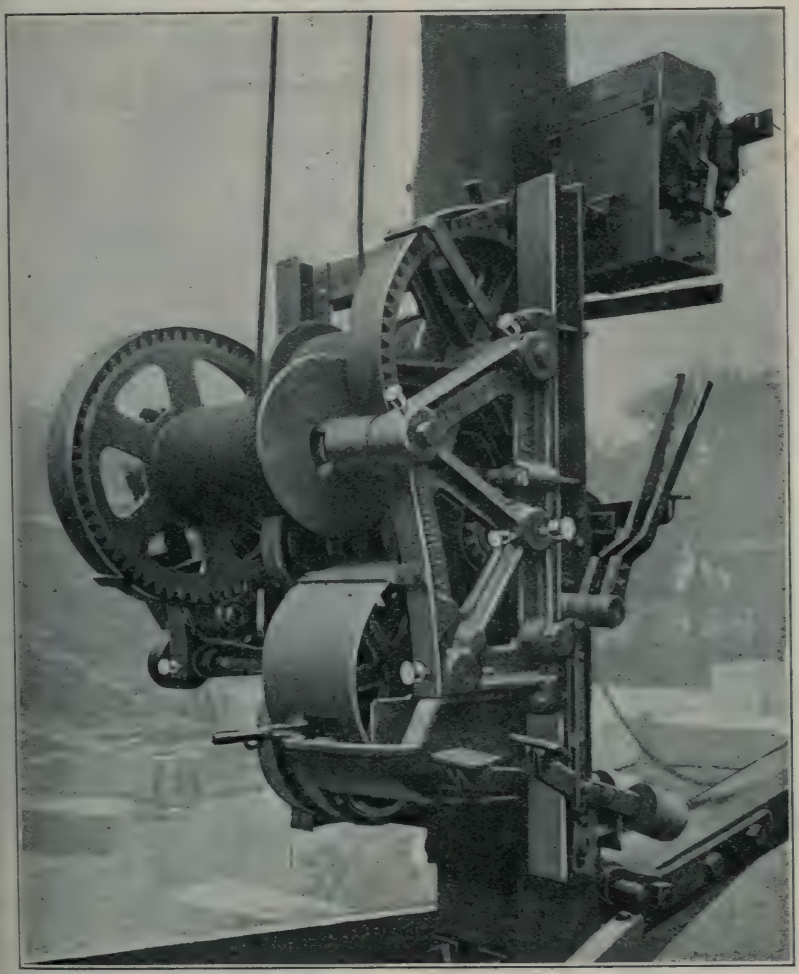
A pump intended primarily for contractors' use has been brought out by the American Well Works, Aurora, Ill. This pump is made in only one size a 2½ in. standard. The manufacturers recommend it for heads up to 57 ft. and state that it will deliver under field conditions from 70 to 250 gal. per minute. For instance working under a 50 ft. head it will deliver 120 gal. per minute at 1000 r.p.m. The pump is connected to an air cooled "New-Way" gas engine through flexible coupling, the shaft being supported on a pedestal bearing. A thrust bearing is provided so that the most rigorous conditions of general service are provided against. Casing is of cast iron of the volute type, designed particularly to meet the rigorous conditions of general service. It can be swung on its bolts so that the discharge opening may have any of eight positions. Suction nozzle is cast in the casing and companion flanges are furnished for suction and discharge openings. Cover is of cast iron. The impeller is made of special cast iron, carefully machined and balanced. The base is of cast iron, box type, made unusually heavy to withstand hard service. It is provided with four lugs for floor bolts.



American EFFD Centrifugal Pump.

New Double Drum Mast Hoist

A double drum 2-speed electric mast hoist designed to replace the old hand power winch on derricks handling occasional loads is a recent product of John T. Horton Co., 241 Bradhurst Ave., New York City. The frame is made up of structural steel sections securely riveted. The side bearings are of cast-iron bolted to the steel members. All bearings are accurately machined and lubricated by grease cups. The two speed gear shaft bearings are bronze bushed. The gears are of cast-iron moulded from machine cut iron patterns. The main drum gears are 3 in. face. The first gear reduction from the motor has machine cut teeth. All gears are well guarded. The shafts are of the best quality cold rolled steel. The frictions are of the single cone type composed of hard seasoned wood segments accurately turned and bolted to the friction wheel. Each drum is handled by an independent friction operated by cams and fitted with high quality thrust ball bearings. Th e brakes operate on the pinions engaging the drum gears, giving easy control of the load. The brake wheel and pinion are cast in one piece and fitted with bronze



Double Drum 2-Speed Electric Mast Hoist.

bushings. The brake bands are lined with "Thermoid" brake lining and controlled by foot levers. Drum gears are also fitted with holding dogs. The drums are of cast-iron 9 in. in diameter, 18 in. between flanges. Capacities: Using the slow speed, it is stated, the hoist will handle a load of 6000 lb. at 20 ft. per minute on a single line, or with fast speed a load of 2200 lb. at 65 ft. per minute. On a derrick with a four part line this would be equivalent to handling 10 tons at 5 ft. per minute, or 3 tons at 16 ft. per minute.

Portable Vise Stand and Pipe Bender

A portable vise stand and pipe bender placed on the market by H. P. Martin & Son, Owensboro, Ky., is illustrated. One of the chief uses of this outfit is in cutting and threading pipe. When this sort of work is being done the pipe is fastened to the vise. It rests in the bending attachment, which keeps it rigid and always in line. The front legs of the device are placed so as to brace the stand thoroughly against the twisting motion

Martin Vise Stand and Pipe Bender.

necessary in cutting or threading. The outfit is equipped with a special device which will bend pipes or conduit from ⅛ to ¾ in. in diameter easily and without kinking. The rear legs of the stand are placed at an obtuse angle so that great pressure may be exerted downward on the pipe without tilting or upsetting the stand. It is stated that the vise stand and pipe bender can be dissembled and packed for carrying in a half minute's time and is as easy to carry as a suitcase. When in use, it is not necessary to have it fastened to the floor, wall or ceiling. No bolts, screws or braces of any sort are necessary. It weighs only 45 lb. The outfit is supplied in four combinations as follows: Stand and bender alone with vise and legs; stand and bender with vise and without legs; stand and bender with legs and without vise; stand and bender with vise and legs complete.

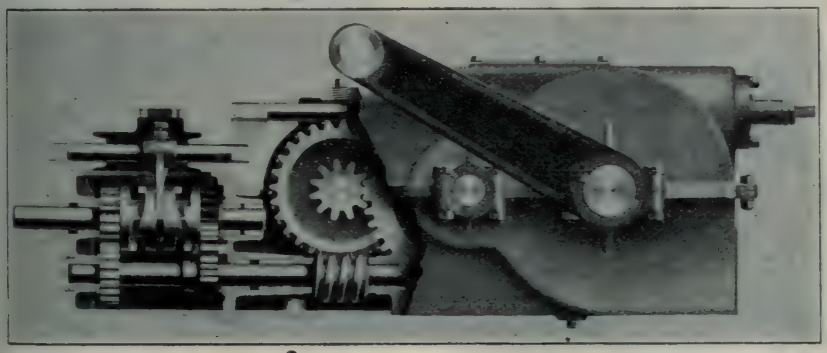
Mechanical Dump Truck Body Hoists

Two types of hoists made by the Van Dorn Iron Works Co., Cleveland,

Cutaway Section Showing Principle of Operation of Vertical Hoist.

O., are illustrated. The vertical hoist is operated by the screw jack principle. When a convenient control lever, reached from the drivers' seat,

is pushed to the rear, the hoist clutch engages the power take-off of the truck engine to rotate a heavy jack screw in the proper direction to raise a large bronze nut which is threaded to the jack screw and fitted to the lower part of the hoist plunger. The hoist is entirely automatic in action, stopping automatically when the body is elevated to a 45° dumping angle. The body can be stopped and held at, or lowered, from any angle up to this point. The truck can be driving away while the body is lowering, as the hoist disengages and stops automatically as the body settles to its bed. One outstanding feature of safety of the hoist is the fact that gravity plays no part in lowering the body. The jack screw must be revolved in a reverse direction so that the body is pulled down by the same power which raised it. In the horizontal hoist the power developed by the truck engine is transmitted by a series of spur and worm gears to a 1 to 350 ratio. This hoist is also automatic in action, and is self-lubricating. The connection between the hoist and the hoist body is made by a link and arm connection which insures positive control at all times. When the body is in a lowered position the link and arm are folded up in a compact, jackknife fashion. As the hoist is operated the arms swing upward and straighten out to raise the body to a steep dumping angle. The body can be stopped at and lowered from any angle. It is not necessary to carry the body to the full upward stroke of the connecting arms before it can be lowered. The arm and link always maintain a rigid connection between the hoist and the body.



Side Cutaway View of Horizontal Hoist.

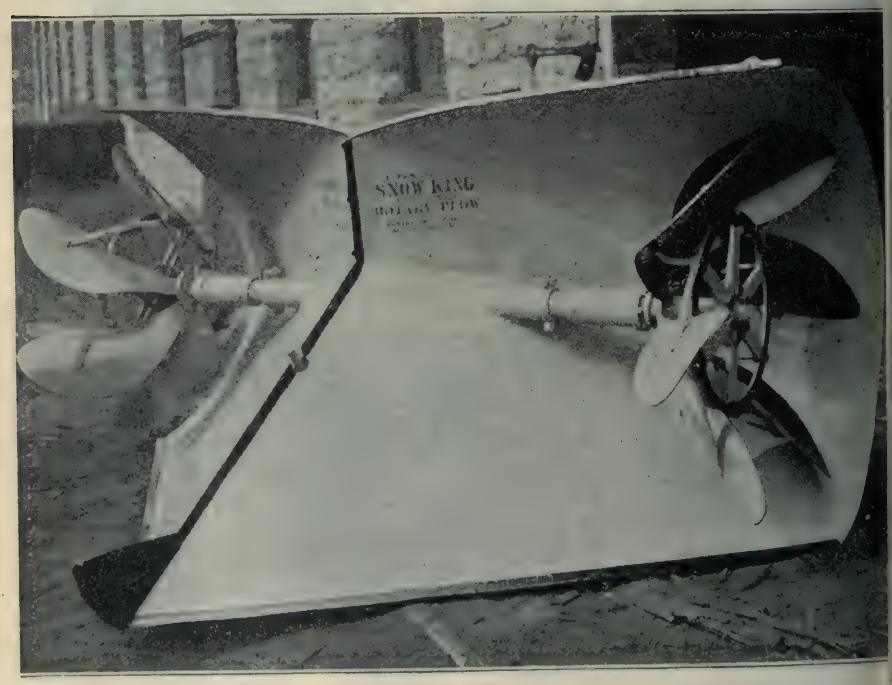
New Piston Ring

A piston ring having new features has been brought out by the Kendall Motor Products Co., Fort Wayne, Ind. The pistons are of two-piece construction, an inner or expansion ring and an outer or packing ring. A special analysis iron being used, which after having been thoroughly seasoned is further improved by a special returning process on the expansion ring, producing what is termed an "even-radius"-type ring, having equaradial expansion every 30 degrees on the entire circle, all points having equal pressure. This is especially beneficial in slightly out-of-round cylinders. A non-clogging oil wiper is also provided in this section of the ring. The outer or packing section is of softer non-resilient iron, being turned with an inner surface on a 55-degree angle, the expansion ring having an externally inclined face of the same angularity, thereby relieving groove pressure and increasing pressure on the circumference, lengthening the life of the expansion ring.

Kendall Piston Ring

A Rotary Snow Plow

A rotary snow plow having fans that revolve parallel to the propelling vehicle and a specially designed plow to bring snow to the rotaries is now being manufactured by the Rotary Snow Plow Co., 213 South 6th St., Minneapolis, Minn. The plow is of the "snub nose" type, with specially designed wings so curved as to bring the snow to the rotary fans with the least amount of friction. The wings do not touch the ground, but are fastened to the top of the sliding shoes. A caster wheel supports the plow and swings it clear of the surface when traveling over bare ground. There are two rotary wheels, one on each side of the plow, revolving on ball and roller bearing equipped shafts. They are from 3 ft. to 5 ft. in diameter depending upon the size of the plow. They can be thrown in or out of gear separately and so revolve only when needed. The power for driving the rotaries is taken from the motor of the propelling vehicle. It is transmitted by means of a shaft, attached to the crankshaft, through a universal joint, so designed that if the rotaries should strike an immovable obstacle, the outside connection will give, and no damage result to the motor. The power shaft is fitted with a pinion, revolving on a ring gear, which in turn drives the rotaries by means of cross shafts. Everything is enclosed in a steel housing, and all working parts run in oil. Attachment to the propelling vehicle is made by means of a hitch, designed to fit the particular type of tractor or truck used. Flexibility is had by means of two loosely fitted connecting arms, attached to, and swinging between the frame brackets and vehicle on a line with the universal joint. When working the plow does not depend on travel speed. The rotaries revolve regardless of the speed of the propelling tractor or truck. Three sizes of highway plows are available. The smallest of these cutting an 8 ft. path can be operated with a 25 h.p. tractor or 3-ton truck. The next larger size is a 10 ft. plow. This will require a 40 h.p. tractor; and the largest size, cutting a 12 ft. path requires a tractor with 60 h.p.



The Smaller Model of the Snow King; Cuts an 8 Ft. Path.

Expanded Wood Lath

Wood, cut and expanded in a fashion similar to expanded metal, for use as a base for plastic coverings on either inside or outside work is the product of the Expanded Wood Lath Corporation, Conway Bldg., Chicago, Ill., and Tuscaloosa, Ala.

This product, which bears the trade

Applying First Coat on Expanded Wood Lath.

name "Ex-Wo," is described by its makers as follows:

It is a strip of carefully selected wood, manufactured by specially constructed machines, then expanded so as to form longitudinal strips connected by diagonal ribs.

The ribs are narrower than the strips so that the plastic covering when applied passes beneath and around these ribs, forming a perfect key, thereby becoming an integral part of the structure to which it is applied. The back of the lath is covered with paper of varying thicknesses to meet all requirements.

Ex-Wo Lath is manufactured in two thicknesses: 5/16-in. and ⅜-in.; 16 in. wide; 4 ft. to 8 ft. long. Packed in bundles of 15 sheets in a bundle.

If used on sheathing or covering of old houses it removes the necessity of papering or furring. The furring is part of the lath itself.

It is so constructed that it adds the greatest strength to the building. The wood of the lath is so cut and distributed that it cannot buckle.

It can be applied easily, quickly and cheaply, being 18 in. wide and 8 ft. long.

It may be applied to either straight or circular surfaces, horizontally or vertically.

It may be shaped around corners and angles, meeting every requirement for interior or exterior work.

It saves plaster. There is a full clinching or plastic covering back of the lath. A careless workman cannot waste plaster.

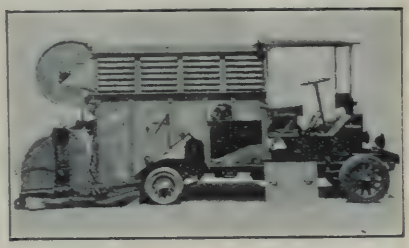
Being made of wood there is no oxidization of the body of the lath with subsequent expansion and contraction and deterioration.

The load of the lath is properly distributed.

It is to a great extent sound-proof. It adds warmth.

A Suction Street Sweeper

A street sweeper, utilizing a revolving broom and the suction from a powerful fan—the same principle used in home vacuum cleaners—is illustrated. The broom is of special sectional design, so arranged that any one or all of the eight segments can be adjusted or replaced in a few minutes time. The broom loosens the debris and picks up the heavier material, delivering it to an inclined belt conveyor which carries it upward and forward, dumping it into the dust compartment.



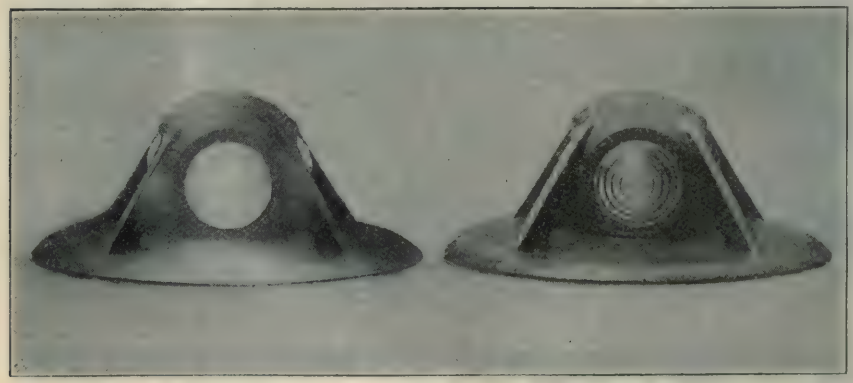
Butler Vacuum Street Sweeper.

The fine dust is sucked up by the suction from the fan and sifts through vacuum cleaner bags carried in the top of the body structure. This dust finally drops from the hoppers into the dust compartment and is removed with the heavier material. These bags are so constructed as not to need renewal. The machine is equipped throughout with ball or roller bearings. The driver is located on the

right, in front, where his view is unobstructed, and he controls the sweeping mechanism with a single lever. The dust pan can be raised, when not sweeping, from the driver's seat. The broom case, in the rear, "floats" to provide for uneven surfaces of pavement and is supported in the rear with two rubber tired casters. Only one broom is used, no gutter brooms being necessary. The construction is rugged, the control is simple, the operation is quiet and efficient. A heavy duty Waukesha motor is used with standard accessory equipment. The Brown Lipe transmission provides three speeds forward and one reverse. A Columbia front axle is used with a Russel axle on the rear. Wheels are of heavy military type equipped with solid rubber industrial truck tires. The wheel base is 117 in. The sweeper is about 18 ft. 6 in. in overall length and 6 ft. in width. It is made by the Butler Manufacturing Co., 12411 St. Clair Ave., Cleveland, O.

Illuminated Traffic Control Unit

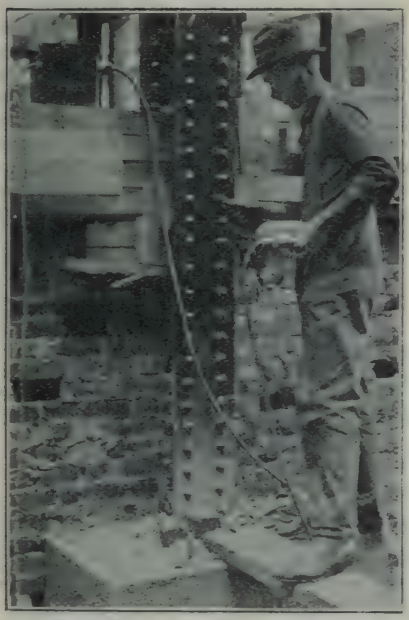
An illuminated market for control of traffic at street intersections has been brought out by the Line Material Co., South Milwaukee, Wis. It consists of a semi-steel hood extending 8½ in. above the street surface. A brilliant "bulls-eye lens" is set in the hood, perpendicular to the street surface, on all four sides of the marker, facing all four points of the intersection. These lenses condense the light into a strong beam up and down the intersection, and permit the use of low watt lamps. Inside the hood are two sets of electric lights—a 25 watt main lamp and two auxiliary lamps of 10 watts each—for night and day use. The lenses are protected by their recessed position and the heavy ribs or flanges on all sides that the possibility of glass breakage is very slight. The lenses are heavy enough to resist breakage by mud and stones. It is stated that the whole unit may be driven over without injury by a heavy truck. In installing these markers iron pipe or armored cable is run under the pavement from the service connection to the location in the street where the marker is to be installed. The base casting of the marker is set into concrete and the wire connections made. The lamps and fuse are then screwed in, and the top casting fitted in position over the base. The top casting is easily removed to make lamp adjustment. This marker is known as the "Trafficon." It is made in three types—the directing marker, the regulating marker and the zone marker. The distinguishing feature of the Regulating Trafficon, a feature which makes possible its simple construction and low cost, is that it substitutes the single word "Stop" for the three signals usually employed in traffic control devices, namely, "Stop," "Traffic Change," and "Go." The Regulating Trafficon is 17 in. over-all in height above the street surface. The "Stop" sign is 3⅝ in. above the street surface and the center of the lens is 11¾ in. above the pavement.



Lighted and Unlighted Units.

Electric Hammer for Drilling, Chipping, Etc.

A general purpose electric hammer with interesting features has been

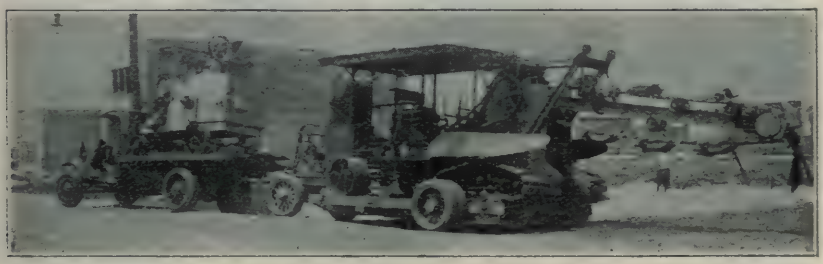


Syntron Electric Hammer Being Used by United Electric Light Co., Springfield, Mass., for Cutting Holes in Brick Foundation Wall.

brought out by the National Electric Manufacturing Co. of Pittsburgh, Pa. The instrument is known as the "Syntron" electric hammer. A distinctive feature is the use of only one moving part in its mechanism. The hammer is of the Solenoid type and consists of a bronze sleeve in which the hardened steel piston or hammer head oscillates, striking the drill head at one end of the stroke and the buffer spring at the other. The action of the piston is produced by coils at each end of the bronze cylinder. In operation the power is obtained by connection through a portable control box to any convenient alternating light socket. When the trigger is pulled the alternating voltage causes the coils to become temporary magnets, and the hammer head is drawn back and forth in the bronze cylinder in synchronism with the voltage. The 60 cycle current hammer is stated to strike 3600 blows per minute. The control box is a static device which contains non-moving parts, and it is stated that the hammer uses less current than the ordinary domestic iron. In the manufacture of the above mentioned piston or hammer head, use is made of a hard non-magnetic stellite cap which is flowed onto each end of the piston by acetylene gas process. One of the outstanding advantages of this cap is that it permits the use of a core material having a very low electrical loss which increases both power and efficiency of the hammer. The hammer has been found useful in drilling or chipping concrete or cutting holes in masonry. In concrete it is claimed it will drill a 1 in. hole 3 in. deep in 1 minute.

Trailer for Hauling Heavy Equipment

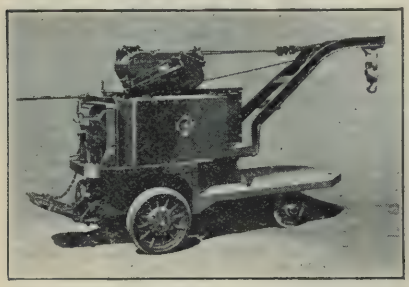
A 20 to 30-ton capacity trailer for hauling ditch digging machines, steam rollers, steam shovels and other heavy equipment made by the Detroit Trailer Co., Detroit, Mich., is illustrated. These trailers are 136 in. overall width, 98 in. between wheels and the platforms may be 14, 16, 18 or 20 ft. long. The illustration shows the outfit used by the John A. Mercier Co., contractors, Detroit, Mich., hauling a 30 ft. ditch digging machine.



Hauling a 30 ft. Ditch Digging Machine on Trailer.

New Crane for Industrial Hauling

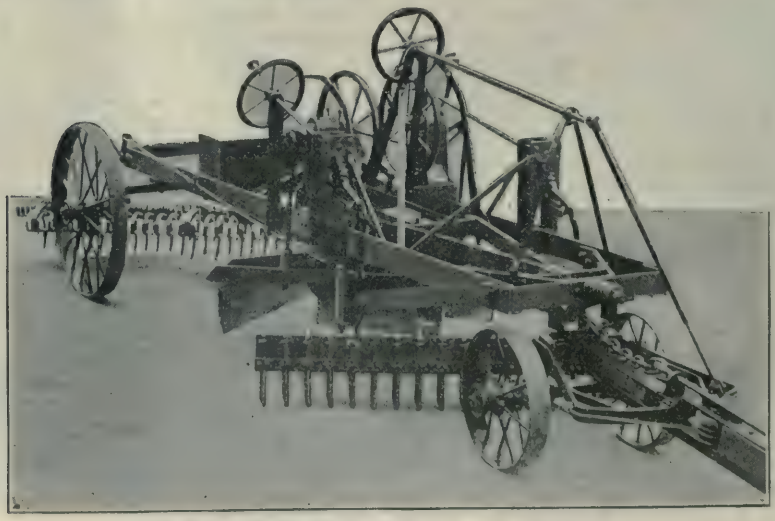
The Elwell-Parker Electric Co., Cleveland, O., has recently announced the seventh model of electrically operated portable crane for industrial handling. This crane consists of the lifting unit, power plant and battery counterbalancing the boom. This is supported on a stalky steel column set into a heavy base firmly anchored to an all steel frame fitted with axles of wide gage. Hoist mechanism consists of a single motor driving two separate drums through worm gearing running in oil. Each drum is fitted with a ⅝ in. plow steel cable, one to raise and lower the boom, the other to handle the hook. Each is operated independently so that the load may be picked up at any point over end or side of the tool (the boom swinging from left to right). The unit is moved from point to point by means of an electric motor, direct connected through worm gearing on the heavy axle beneath the battery and just back of the crane column. This motor as well as the hoist motor receives power from the same battery. Leads from this battery which swings with the boom pass down through the hollow crane column. A separate controller operates each motor. Where the service demands, a motor to revolve or slew the crane is provided and it also receives power from the same battery. The forward axle or that nearest the hook is quite heavy and serves as a rolling outrigger, the wheels being equipped with 15 x 3½ in. solid rubber tires. The drive wheels are provided with 22 x 4½ in. tires. All four wheels steer.



New Electric Crane Truck.

Stone Rake and Rut Scraper

The picture below shows the general character of the "York Power Stone Rake and Rut Scraper" made by the York Modern Coporation of Unadilla N. Y. The machine is designed for the filling of ruts the planing of road surfaces and the raking out of stones. It is made in three sizes equipped with steering device and two-way rut scraper.



York Power Stone Rake and Rut Scraper.

A Compact and Powerful Underground Loader

The Butler Shuveloder, manufactured by The Lake Superior Loader Co. of Duluth, Minn., was developed on the properties of the Barusdall Zinc Co., at Waco, Mo., by Mr. R. S. Butler, assistant manager of the company. The first operating model was built in 1919, and was followed by others, one of which built in November, 1920, was in successful operation for 2 years—long enough to determine the value of the split piston and other new ideas, and to prove that the lightness of the machine was not a deterrent to heavy loading. Subsequent improvements also were tested in extra severe service.

View of Butler Shuveloder in Actual Underground Operation, Showing Start of Crowding Stroke and End of Crowd and Beginning of Digging Stroke.

The following account is excerpted from a paper, "Recent Developments in Underground Mechanical Loading" by Charles E. van Barneveld, U. S. Bureau of Mines, in the Engineering and Mining Journal-Press of Sept. 22, 1923.

The successful demonstration at the Waco, Mo., mines of the Barnsdall Zinc Corporation of the latest model Butler shovel, which invades a field hitherto covered only by the scraper and thus promises to meet the need of the western miner for a small, flexible machine, readily movable on mine cage from one level to another, available alike for loading in drifts—as small as 4½x7 ft.—and for fairly heavy loading in comparatively large tunnels, stopes and rooms.

The Butler shovel or "Shuveloder," as its manufacturer calls it, is a small single-cylinder air-operated shovel of the revolving type. Its design incorporates many novel features which combine to produce a simple, light yet rugged machine, with very low power requirements, adapted to a wide range of service.

Though the operation of the machine is simplicity itself, a simple straightforward description presents difficulties because the principal parts each perform several different and closely interrelated functions during the successive motions included in a complete operating cycle. The machine consists essentially of three main parts. (1) base, (2) cylinder, (3) dipper assembly.

The trucks carry the stationary member of the turntable. Supported on this turntable by a double row of balls is the revolving member, which contains a 2-hp. double acting 2-cylinder oscillating engine, which revolves the turntable. On this revolving member are cast the side frames that support the cylinder. The entire base is made of No. 3 artillery steel; it is protected from dirt and grit and is automatically lubricated by the oil contained in the exhaust air Auxiliary means are provided for oiling the crank bearings.

There is one cylinder only, supported at its trunnion by the side frames. The cylinder is steel tubing and the trunnion, yoke and heads are made of artillery steel. In this cylinder are the two pistons, each secured to a hollow piston rod, one within the other. The valve controlling the movement of the pistons is incorporated in the cylinder trunnion and is operated directly by a hand lever. On the bottom of the cylinder is a bracket which engages with the base to take the back thrust when crowding, instead of absorbing this thrust at the

trunnion point, thus avoiding strain on the mechanism and tendency to pull up the track.

The frame carries a pair of guide and supporting arms with their links, which are attached to the rear of the dipper arms. The dipper is mounted on the front end of these arms in such a manner that when the air pistons are spread apart the dipper rocks on its pivot with a scooping action. A pair of hydraulic pots whose pistons are attached to the supporting arms, control the dipper during the entire elevating stroke, determine the path of the dipper while extending prior to dumping, and cushion the descent of the dipper.

There are comparatively few moving parts and the wear is principally confined to pins and bushings easily replaced. This is not a cycle machine; it is flexible as a steam shovel and in normal operation is almost automatic. The operator throws the valve wide open; the movement requires no nursing, no delicatte manipulation; the momentum of the moving parts is checked by air cushions in cylinder heads; the dipper strains are absorbed by the arms and hydraulic pots; the piston rods have only tensile and compression duties. There are no cables, chains, pulleys, or clutches; no rollers or exposed sliding surfaces to catch dirt and grit. There is one gear assembly only—ring gear and two mating gears for revolving motion—enclosed and thoroughly protected from grit, yet easily accessible for repairs.

The following references are from a folder issued by the manufacturer.

Track gauge to suit conditions.

Air consumption is less than 125 cu. ft. per minute at 10-90 lb. pressure.

Maximum capacity is four 7½ cu. ft. dipperfuls a minute or over one and one-half tons per minute.

Average actual performance under ordinary conditions is 15 to 30 tons per hour.

Digs and loads in any direction into 48-in. cars or higher if necessary.

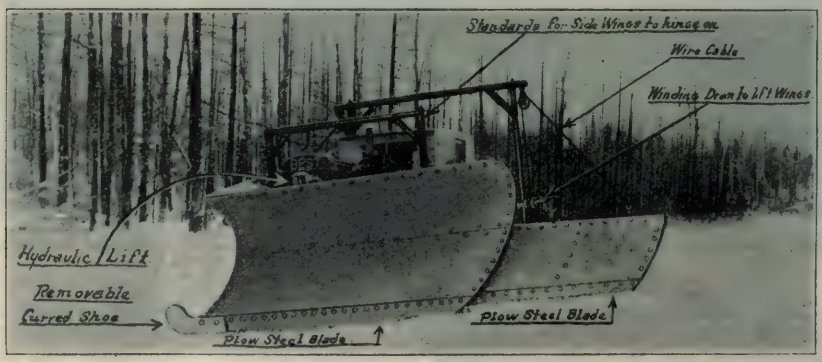
Digs and loads around corners, on step grades, below grade and leaves clean floor and corners.

Can be used in drifts only 4½ ft. wide by 7 ft. high or will clean up a path 18 ft. 6 in. wide.

Can be rolled into a mine cage 3x 3½ ft. without disassembling for transfer to different mine levels.

New Snow Plow

An all steel V-shaped snow plow having a hydraulic lift for raising and lowering has been brought out by the La Plant-Choate Manufacturing Co., Cedar Rapids, Ia. The lower cutting edge is a special plow steel blade, and the plow is so shaped that the nose makes a long sharp cutting point. A steel shoe that fits over the nose of the plow, and which can be removed, is furnished. This is intended for use at certain times to prevent the possibility of the plow digging in and injuring the paving or street. This steel shoe can be used in medium snows and where the snow is not frozen, and therefore where the cutting point is not so necessary. The side-wings on the plow can be adjusted at any angle, and can also be adjusted vertically. The mold-boards are shaped like the mold boards on a dirt

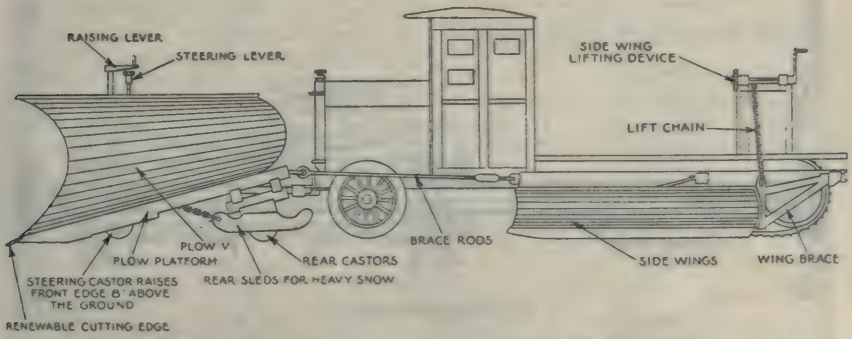


La Plant-Choate Snow Plow.

plow, so that they take care of the snow and throw it up and over and outside of the cut. The company will manufacture six different models of tractor plows, three of tractor blade plows, and three of tractor "V" shaped plows. It will also manufacture three different models of blade plows for trucks, and one model of "V" plows for trucks.

New V-Type Snow Plow

A new V-type snow plow for attachment to heavy tractor has been put on the market by the Good Roads Machinery Co., Kennett Square, Pa. The plow is of the general type used by railroads in keeping snow from their tracks and right of way. It is designed for deep snow and for use with heavy tractors, but under proper conditions it may be used to advantage with two standard 5-ton auto trucks, properly timed for operation together, one pushing behind the other. The snow plow consists of an inclined platform carried on rollers and sleds, with a V-type moldboard mounted on it and a push frame arranged for attaching to the tractor. In operation the plow lifts the snow on its inclined platform and thus breaking the resisting force of the snow rolls it upwards and sideways with a minimum of effort. The plow is mounted on three rollers, two in the rear and one on the front end. The rear rollers are fixed in place and on the same axles are mounted a pair of runners. The front roller is mounted as a caster and is used to help in steering the plow. The roller is spring supported and so arranged as to raise and lower the front end of the plow. It can be adjusted to let the plow rest on the road entirely. Four shoes or bearing plates and a replaceable cutting edge are used to take the wear when the plow is used with the front roller raised, so that the edge rests on the surface of the road. The use of a thrust ball-bearing in the roller support and a T tire shrunk on the face of the roller makes the steering very easy and effective. These features facilitate moving the plow from place to place and also regulate the depth of the snow to be left on the road. The plow is 8 ft. wide, 10 ft. long and 5 ft. high, the front end can be raised 10 in. from the ground. The weight, without the wings is 3500 lb. The plow has been successfully used with 10-ton tractors.



Side View of "V" Type Plow and Wings on Linn Tractor Showing Details of Construction

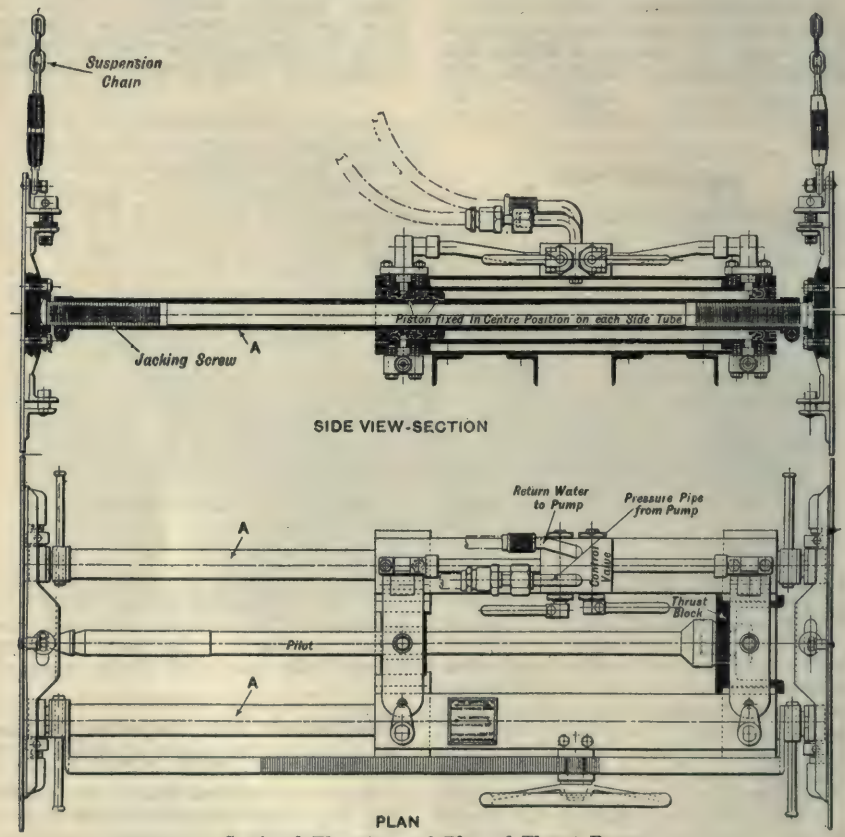
Side View of Champion V-Type Plow and Wings on Linn Tractor Showing Details of Construction.

Compound for Repairing Concrete Floors Quickly

A new compound, known as "Quickfix," for repairing concrete floors that will, it is claimed, produce a patch of flint-like hardness in 48 hours, has recently been developed by The Master Builders Co., Cleveland, O. When used according to the method specified by the manufacturers it is stated that it will produce permanent patches in concrete that can be used two days after installation. The patches can be made by any handy man, not necessarily skilled in the handling of concrete, by following directions furnished with the material.

A Thrust Boring Machine

A thrust boring machine for making 3 in. to 6 in. holes is described in a recent issue of The Enginemen, London. The pilot hole is 3 in. in diameter and this can be enlarged to 4 in., 5 in. or 6 in. by "pulling." The apparatus is shown in the accompanying illustration. The machine comprises two side tubes, which are internally threaded at each end for the reception of jacking screws provided with tommie-bars for adjustment purposes. The outer ends of the screws are provided with thrust plates attached in the manner shown in the drawing. When in position, the tubes are accurately parallel with one another. In the center of the length of each tube is fixed a brass piston, which is furnished with hydraulic cup leathers. Upon this piston fits a cylinder which is caused to move endways, in either direction, by hydraulic pressure. Each side tube has its own cylinder, and the two cylinders, which are interconnected by piping, are rigidly tied together at each end, so as to form what is, in effect, one solid crosshead. The pressure water is supplied through a control valve, which is so constructed that when the handles are down, as shown in the drawing, the pressure is applied at the left-hand ends of the cylinders and the "crosshead" moves to the left. On the other hand, when the valve handles are turned through a right angle so as to stand vertically, the pressure water is admitted to the right-hand ends of the cylinders, and the "crosshead" moves to the right. When either handle is in the half-way position between the horizontal and the vertical, there is free com-

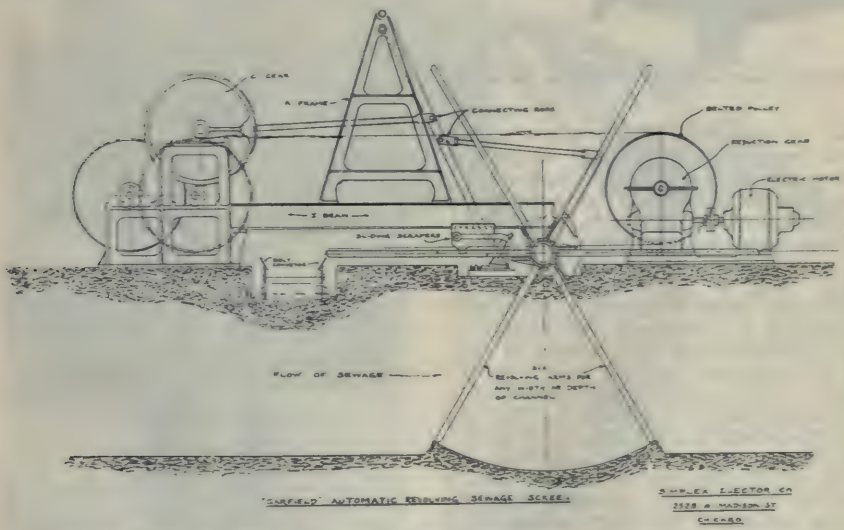


Sectional Elevation and Plan of Thrust Borer

munication between the two ends of the cylinders, so that they can be moved readily backwards and forwards along the tubes or rods. This attribute is made use of in order to obtain a quick return of the "crosshead" for the purpose, either of adding new rods when initial thrust boring is taking place, or for removing the rods when enlargement of the bore-hole is being carried out. To effect the quick return, a rod furnished with a toothed rack is arranged parallel with and not far from one of the side tubes, and a hand wheel, on the spindle of which is keyed a toothed pinion, is attached to the "crosshead." With the control valve arranged as explained, the "crosshead" may be made to travel rapidly along the tubes in either direction by simply turning the hand wheel. At the right end of the "crosshead," as shown in the drawing, there is fixed between the two cylinders a thrust block, through a hole in which can be passed a screwed pin, which is used for centering the pilot bar or boring tubes, and also for taking the load when the machine is used as a puller. It is stated that a boring speed for a 3 in. hole—when using a hand-operated pump—of from 50 ft. to 90 ft. per hour can be obtained, this including coupling of the rods. The normal dimensions of the boring pit to contain the machine is 4 ft. 4 in. long—that is to say, in the direction of the boring—and 3 ft. 6 in. wide; 60 ft. of boring tube—in lengths of 3 ft. each—are supplied with each machine as standard practice, though operations are not, it should be understood, limited to that range. The stroke of the machine is 18 in.—just half the length of a boring tube—so that two machine strokes per tube length are required. The machine is known as the Mang-Nall-Irving thrust borer. It is made by the Hydraulic Engineering Co., Ltd., Chester, England.

Automatic Revolving Sewage Screen

The "Garfield" automatic revolving screen for screening sewage and trade wastes, now being manufactured in this country by the Simplex Ejector Co., 2528 West Madison St., Chicago, Ill., is shown in the accompanying illustration. A feature of this machine is the use of mechanical scrapers with hard rubber soles for cleaning the screens. The screen can be made to comply with any requirement of mesh from 1/16 in. to 1 in. spacings, and to deal with any volume of flow.



Sectional View of "Garfield" Automatic Revolving Screen for Screening Sewage and Trade Waste.

New Solder Pot Has Automatic Control

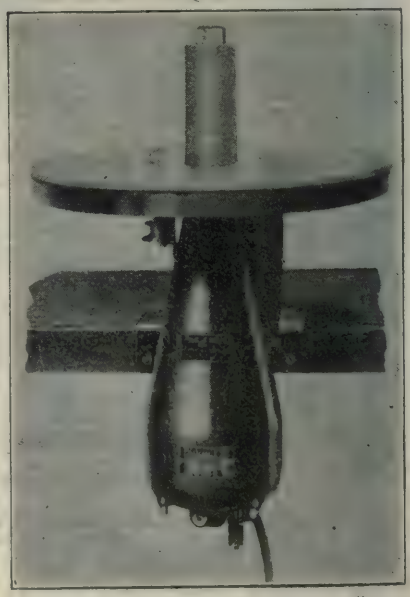
A new electric solder pot with automatic heat control has been added to the line of labor saving devices manufactured by J. D. Wallace & Co., Chicago. It greatly simplifies the problem of heating babbit, white metal, wax and other materials which are slow conductors of heat. Solder must be kept at a uniform temperature if satisfactory results are to be obtained. When metal is overheated it oxidizes, and this action results in a considerable loss of material and tensile strength. The Wallace solder pot is designed to overcome this oxidation. When solder has been heated to 600° F an automatic control goes into action. This control maintains the temperature of the contents of the pot and prevents overheating and underheating. This control is an adaptation of the principle used in the steam gauge. A volatile substance, which is very sensitive to heat, actuates a Bourden Tube which makes and breaks the electric current, thus controlling the temperature of the contents of the pot.

Wallace Solder Pot Complete with Automatic Control.

The pot will accommodate 15 lb. of solder and will heat this amount to 600° F. in 20 to 25 minutes. This quick action is due to the fact that a 900 watt heating element is built around the entire container. Heat is applied to all parts of the sides and bottom of the container simultaneously, thus coming in contact with the solder at all points, and reducing it to a working consistency. The pot weighs only 13 lb., can be easily carried anywhere, and operates on either 110-V. or 220-V. alternating or direct current. Workmen need not waste steps going back and forth between their work and a heater.

Sander for Woodwork Finish

The oscillating spindle sander here illustrated has just been put on the market by the Porter-Cable Machine Co. of Syracuse, N. Y. for the pattern shop or woodworking factory that feels they have not enough internal or irregular work to warrant buying the larger machine heretofore offered. The machine is equipped with G. E. motor which has a speed of 1725 r.p.m. and is totally enclosed. Motor is connected direct through the spindle which has an oscillating movement of 1 in., is equipped with ball bearings and furnished with 2¼ x 6 in. roll. The table of this machine is ground, tilts 45° down and 15° up and is 16 in. in diameter. The weight of the machine is 75 lb. and overall dimensions are 16 x 16 x 25. The machine can also be placed on pedestal if desired.



Syracuse Bench Spindle Sander.

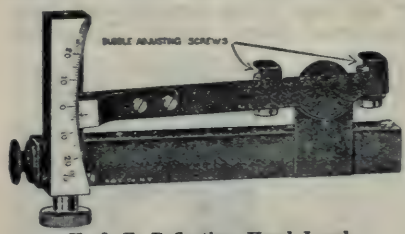
Portable Road Building Crushing Plant and Bin

The outfit illustrated below is made by the United Iron Works, Ridge Arcade Bldg., Kansas City, Mo. The bin is of the wooden type (the company also makes a steel bin), and is hoppered in the center, thus discharging to both sides. The wooden bin is lined with steel to increase its serviceableness, both from the standpoint of wear and to make the crushed product discharge more readily. The bins are divided into two or more compartments for different sizes of product. Our standard bin is built in two sizes, 15 and 30 cu. yd. capacity. A three compartment bin therefore has a capacity of 5 and 10 cu. yd. respectively to each compartment, depending upon the size of the bin. The illustration shows the outfit ready for moving, with the bin lowered and the elevator folded.

United Crushing Plant and Storage Bin.

Reflecting Hand Level

A reflecting hand level intended primarily for use in preliminary surveys of roads, railroads, etc.; but which also may be employed for the same purposes as any clinometer where the slopes or gradients involved are not greater than the equivalent of 11 deg. 15 min. above or below the horizontal, has been placed on the market by Keuffel & Esser Co., New York. In this instrument the bubble-tube is large and has adjustment devices similar to those on the bubble tubes of a surveyor's transit. The graduated limb is set perpendicular to the line of sight; and is graduated in per cent of grade up to 20 per cent above and below the horizontal. The length of the limb permits direct grad-



K. & E. Reflecting Hand Level.

uation to single per cents; and the spaces being large, it is possible to estimate to the nearest 0.2 of one per cent. The movable arm, which carries the bubble and pointer, is operated by means of a tangent screw, whose head is at the base of the graduated limb. Hence, the bubble may be brought slowly and uniformly to the center of its tube, instead of, as in the Abney level, requiring a direct operation of the hand in positioning and clamping it. The location of the limb and tangent screw at the sighting end of the instrument permits the use of both hands in directing it steadily upon the mark while bringing the bubble to the central position. All of the above mentioned features make possible a considerable degree of precision in measuring slopes and gradients up to 20 ft. rise in 100 ft. of horizontal distance. The instrument is equipped with a narrow prismoid reflector, so located that the field of view appears on both sides of the reflected bubble.

One-Man Single Acting Track Jack

A track jack designed for operation by one man under normal track loads has been brought out by Templeton,

Simplex Improved Single Acting Track Jack.

Kenly & Co., Ltd., Chicago, Ill. It is stated that this jack requires 27 lb. at the end of a 66 in. lining bar to lift 1 ton. Thus a 150 lb. man can lift 4¼ tons with his weight alone which is well about the loads met with in ordinary track work where main line track is lifted 1½ in. or 2 in. This increase in power is obtained by use of the trunnion type of construction on the socket in place of the pin. The trunnion is stated to be not only unbendable and unbreakable but permits the shortest possible distance between the trunnion and pawl seat and as a result the greatest power. To obtain this increase of power, it was also necessary to change the pitch on the rack bar from ⅝ in. to 15/32 in., and the jack therefore lifts a shorter distance per stroke. Careful tests have shown that in spite of this fact, the jack is faster in operation than a jack with a larger pitch except for very light loads of approximately 1½ tons, and under. The jack is so much easier to operate that the men take more strokes per minute than with a jack having a coarser pitch and less power. This additional power has made greater strength necessary. To insure this, both pawls are built with double teeth and all parts except the socket and standard are heat treated high carbon steel forgings. Laboratory tests have shown the breaking load of these jacks to be in excess of 25 tons. This strength has been obtained by the use of better materials and more careful heat treatment and has therefore required no additional weight. The jack is constructed with the standard Simplex cored base.

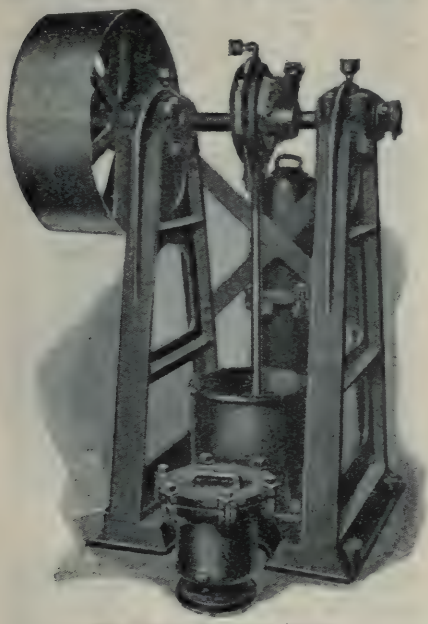
Trailer for High Speed Power Units

A trailer designed for use with the Fordson at its high speeds and with other speed power units is illustrated. The trailer is ruggedly constructed for its rated capacity of 6,000 lb., yet the weight is low, only 1,650 lb. of the chassis. The trailer has Timken taper bearings, standard S. A. E. solid tires, "Electric" steel wheels and Alemite lubrication. The front wheels are mounted on steering knuckles, thus giving a more uniform support to the frame than is possible with a pivoted axle. The draw bar is attached to the front axle, sparing the frame from all pulling strain and eliminating any tendency to "whip" or "wobble" in action. This trailer is made by the Electric Wheel Co., Quincy, Ill.

Trailer for Use With Fordson Tractor and Motor Trucks.

Pressure Pump for Handling Sludge

A pressure pump designed for handling with a steady strong pull, sludges, pulp, and similar material met with in sanitation, chemical and metallurgical fields, has been placed on the market by the Dorr Co., 247 Park Ave., New York. The new pump is of the diaphragm type and due to an ingenious new double diaphragm is claimed to offer all the advantages of the old Dorrco pump with the added benefit of a continuous flow



The Dorrco Pressure Pump.

against a pressure of over 20 lb. The new diaphragm consists of two Dorrco cord diaphragms, facing, with a small space between them. This space is filled with water, which, by means of a check valve connection with water kept above it in the bowl, is made to exert an internal pressure equal to the pressure against which the pump is acting. By means of this equalized pressure it is found that neither diaphragm is strained appreciably on either stroke, at reasonable pressures. The diaphragm is raised and lowered by an adjustable eccentric and rod. On its up stroke it draws the material up through a one way valve and on the return stroke pushes it up through another one way valve and into the discharge line. An air chamber above the second valve equalizes the flow. Every part is of rugged construction and is designed for hard continuous service. Cast iron and steel, with brass or bronze fittings, is used for ordinary purposes, while for acid or corrosive materials antimonial lead or other alloy may be used in the pump body.

Asphalt Simplifications Effective January 1

After Jan. 1, 1924, "Too many asphalt grades" no longer will be the complaint of public highway officials, engineers, contractors, and producers, the U. S. Department of Commerce having announced that upon that date, the recommendatiois adopted at its recent asphalt paving conference, will become effective and asphalt grades for use in the construction of sheet asphalt, asphaltic concrete, asphalt macadam, and surface-treated pavements will be reduced from eighty-nine to nine. The number of asphalt grades used as joint filler in the construction of brick and block pavements and various other types has likewise been reduced from fourteen to four.

A complete report of the conference at which the reduction in the number of asphalt varieties was adopted is in process of printing and will be published about December 1 by the Department of Commerce as one of its series on "Elmination of Waste in Industry." It will be entitled "Simplified Practice Recommendation No. 4—Asphalt" and can be obtained from the Superintendent of Documents, Government Printing Office at Washington at 5 ct. per copy.

The endless multiplicity and nonuniformity of specifications having reached a point which demanded nation-wide co-operative action on the part of engineers, contractors and producers, at the suggestion of Secretary Hoover, a systematic approach to a solution was made during the spring and summer by all parties interested and a constructive reduction of the varieties or grades was effected.

Nine definite penetration limits for the construction of sheet asphalt, asphaltic concrete, asphaltic macadam pavements and for surface treatment, and four penetration limits for joint filler for various other types of construction, including brick and granite

block pavements, were unanimously adopted at a general conference held at the Department of Commerce on May 28, 1923, and have been officially accepted as the standard of practice by the highway engineers of thirty states, the American Society for Testing Materials, the Society for Municipal Improvements, the American Society of Civil Engineers, the United States Bureau of Public Roads, the Asphalt Association, and five manufacturers not members of the Asphalt Association. It was the sense of the conferees that the recommendations should become effective on all deliveries of material after Jan. 1, 1024, and that they should be subject thereafter to annual review and such revision as the industry may desire.

The following table gives the penetration limits as adopted:

For construction of sheet asphalt, asphaltic concrete, and asphalt macadam pavements, and also for surface treatment.

Penetration Limits		
25 to 30	50 to 60	100 to 120
30 to 40	60 to 70	120 to 150
40 to 50	85 to 100	150 to 200

For joint filler for various types of construction.

Penetration Limits	
30 to 50	60 to 70
50 to 60	85 to 100

The first is used primarily for brick pavements, and does not require the admixture of sand, whereas the latter three which are identical with three of the grades adopted for asphalt pavement construction, are those which would ordinarily be used in admixture with sand to produce an asphalt grout.

In adopting these limits, it is understood that the producer will furnish asphalts with penetration equal to the mid-point in each range, a plus and minus tolerance from that mid-point being acceptable to all parties, but in no case shall the deviation exceed the limits of the grade specified.

New 5/8-In. Portable Electric Drill

A portable electric drill with a capacity up to 5/16 in. in steel has been brought out by Black & Decker, Towson Heights, Baltimore, Md. This drill is very similar to the Black & Decker ¼ in. drill, but has a much more powerful motor and other parts in proportion to its size. It is equipped with a three jaw gear nut chuck for straight shank drill bits. It weighs 7 lb. and has a no load speed of 1400 revolutions per minute.

New Industrial Tractor Has Internal Gear Drive

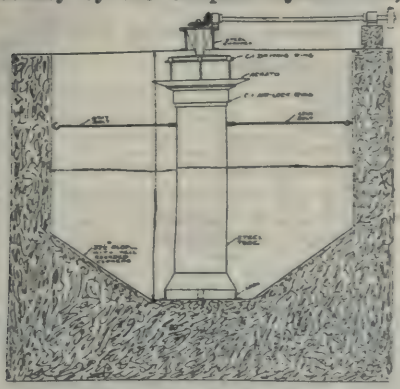
An internal gear drive for industrial tractors has been perfected by the Mercury Manufacturing Co., Chicago, and after three years of experimental operation, a new model—the Type H—has been announced, featuring this drive. The most noteworthy features of the new drive are the balanced arrangement of the driving gears within the wheels; the method used to position these gears in relation to one another; and the successful attainment of an oil and dust tight enclosure for every moving part. The drive—comprising the motor, motor hanger, rear axle housing, rear wheels, rear springs and all driving gears, is assembled in a single unit which may be detached from the frame in five minutes. The sequence of operation in this drive unit is as follows: The motor, joined to a pinion through a self-aligning spring coupler, drives a bevel gear contained in the axle housing. This gear in turn drives the axle pinions to each rear wheel. The axle pinions transmit the power through three idler gears to a large ring gear mounted on the inner diameter of the drive wheels.

Mercury Type H Tractor.

The motor is a high speed, series wound automotive type, its characteristics being exactly fitted to the gear drive and battery assemblies used. The coupling between the motor and the driving pinion comprises four coil springs which cushion the initial starting torque.

Surface Aerator for Activated Sludge

The accompanying illustration shows a surface aerator for activated sludge now being manufactured in this country by the Simplex Ejector Co.,

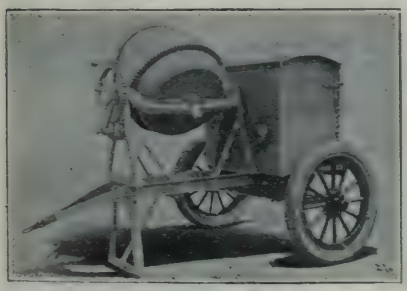


Sectional View of Simplex Surface Aerator.

2528 West Madison St., Chicago, Ill. The operation of this aerator is purely mechanical, and the plant may be driven by electric motor, steam or oil engine. Each aerator is self contained and interchangeable, making it possible to remove any one of them without disturbing the operation of any other part of the plant.

New Trailer Mixer

In order to well round out its line of tilting mixers, the Kwik-Mix Concrete Mixer Co., Milwaukee, Wis., has re-



Trailer Mixer of Kwik-Mix Concrete Mixer Co.

cently brought out a trailer mixer. Embodied in this trailer mixer are a number of advantages tending to make it essentially a portable machine. It is designed and constructed to withstand sudden impacts and shocks without any serious results to the mixer. Besides pneumatic tired wheels which permit greater speed in transporting, the Kwik-Mix trailer is equipped with a double legged stand which affords rigidity to the mixer when it is in operation. Both the handle and stand are bolted to the frame so that when in transportation, should more clearance require it, they can be taken off. This sturdy trailer mixer is compactly made and comes in sizes of 3 and 4 cu. ft. of mixed materials.

Sizes and Weights of Hollow Building Tile Simplified

As a result of a general conference of manufacturers, distributors, and users of hollow building tile held at the Department of Commerce on Oct. 19, under the auspices of the Division of Simplified Practice, it was unanimously agreed and adopted that definite weights and sizes of that commodity be considered as the standard of practice for the industry for one year effective Jan. 1, 1924.

A survey of variety in sizes, dimensions, and weights reported at the preliminary conference of manufacturers held at the Department on June 19, 1923, showed 36 different sizes, each made in a wide variety of weights. A compilation and review of the figures brought out by this survey was made by the Standards Committee of the Hollow Building Tile Association and was used as a basis for adoption at the general conference.

The conference decided to vote on the list submitted by sections and the discussion opened on the 12x12x12 standard load-bearing wall tile for end construction. It was contended that this size did not permit of combined brick and tile construction for the city of Washington. It was brought out by the tile manufacturers that this size would adequately meet the requirements of any construction and that its failure to do so in Washington was due to the fact that builders in that vicinity were not using the standard size brick as adopted at the Brick Conference held at the Department of Commerce on June 21, 1923.

Mr. Sturtevant of the Association explained to the conference that the last four units of tile as listed under standard partition tile were under a course of tests at the Bureau of Standards and their findings would deter-

mine whether they would be classed as floor tile of standard weights. The remaining groups were voted on and unanimously adopted.

After considerable debate as to tolerance for weights and dimensions, it was unanimously passed that not more than 5 per cent tolerance over or under would be allowable for weights and 3 per cent over or under for dimensions covering length, width and height.

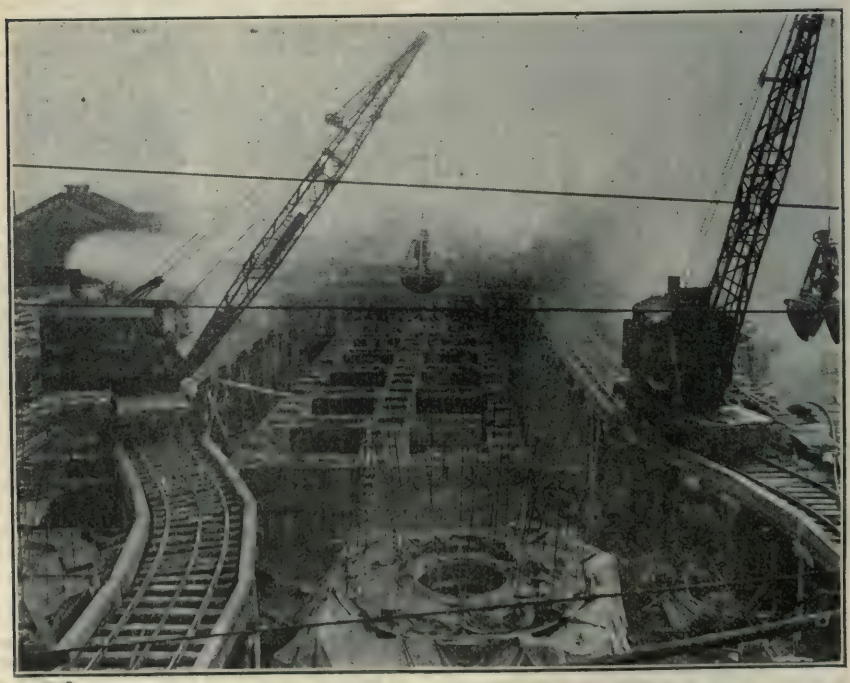
January 1, 1924, was set as to the date the recommendation should become effective and to remain in force for a period of one year from that date.

A standing committee of the conference consisting of three representatives of manufacturers, three of distributors, and three of consumers was decided upon as a means of providing a follow-up to insure the adoption of the simplifications embodied in the recommendation of the conference; to effect a greater degree of contact and co-operation between the Department and the industry; and to consider further eliminations or substitutions in the existing varieties of tile. The personnel of this committee will be announced later.

The following list gives in detail the weights, sizes and types of tile adopted at the conference:

Standard Load Bearing Wall Tile

End Construction	Cells	Wt., Lb.
3¾x12x12	3	20
6 x12x12	6	30
8 x12x12	6	36
10 x12x12	6	42
12 x12x12	6	48
Side Construction		
3¾x 5 x12	1	9
8 x 5 x12	2	16
8 x 5 x12 "L" shaped)	..	16
8 x 6¼x12 ("T" shaped)	4	16
8 x 7¾x12 (square)	6	24
8 x10¼x12("H" shaped)	7	32
Standard Partition Tile		
3x12x12	3	15
4x12x12	3	16
6x12x12	3	22
8x12x12	4	30
10x12x12	4	36
12x12x12	4	40
Standard Split Furring Tile		
2x12x12	..	9
Standard Book Tile		
3x12x18 to 24, per sq. ft.	..	18



Construction View of Philadelphia Anchorage South Caisson of Delaware River Bridge, Philadelphia, Showing Two of the Latest Types of Locomotive Cranes of the Industrial Works, Bay City, Mich.

Portable Gravel Screening and Crushing Plant

A "one piece" gravel screening and crushing plant made by the Iowa Manufacturing Co., Cedar Rapids, Ia., is illustrated. This plant takes the gravel from the pit by an 18-in. belt conveyor in to the screen where the first separation is made. The screenings go directly by second conveyor into the loading hopper bin. Rejections go directly into a Cedar Rapids crusher where they are reduced and returned to the screen by bucket elevator. The crusher, screen, and elevator are mounted on a heavy I-beam goose neck truck, equipped with disc type dust-proof roller bearing wheels, making a very light draught outfit. The screen is of the trunnion drive type, being double 30 and 48-in. diameter screens, which gives large screening area. Conveyors are portable, being furnished with light trucks for conveying with motor trucks. The elevator is of all steel construction with heavy malleable iron buckets mounted on heavy combination malleable iron and steel chain. The crusher is a No. 936 size Cedar Rapids, which has been designed for most severe service. It is very simple in construction.

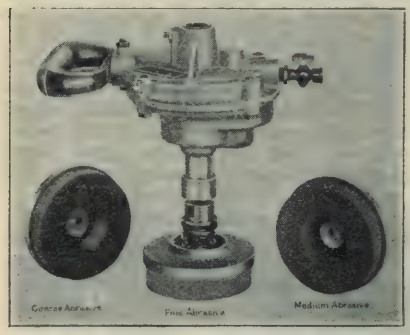
Cedar Rapids Gravel Screening and Crushing Plant.

A Means for Increasing the Efficiency of Radiators

For esthetic reasons, and also because it has become a custom, the radiators employed in heating buildings are usually painted with aluminum or bronze paint. From the viewpoint of obtaining the maximum amount of heat from a radiator of a given size, this is one of the most inefficient paints that can be applied. Tests in progress at the U. S. Bureau of Standards on the emissivity of sheet iron covered with white paint, enamel, and aluminum paint show that the aluminum paint emits only 27 to 30 per cent as much as a non-metallic paint or enamel. It has been known for some time that aluminum paint is not so good a radiator as a non-metallic paint, some published data indicating that the emissivity of aluminum paint was about 75 per cent that of a non-metallic paint, such as iron oxide. With increase in age and other deterioration, the surfaces used in the present test would increase in emissivity, but, states a Technical News Bulletin of the Bureau, it is evident that for efficient service we should educate ourselves so as to become accustomed to the use of non-metallic paints, such as the oxides of iron, chromium, white paint, etc., for metal radiators.

Concrete Surface Grinder

The machine illustrated in the accompanying cut has been developed by the Turbine Aid Tool Co., 301 Chamber of Commerce Bldg., Cleveland, O., for the finishing of concrete surfaces. It removes by grinding all films, marks, fins, and other irregularities,



Turbine Air Concrete Surfacer.

and prepares the surface for a gloat finish or for paint.

The machine is usable on ceilings as well as on walls and floors and is adaptable either to monolithic work or pre-cast units. Either old or new work may be finished in this manner; and natural aggregate surfaces are easily given an attractive finish.

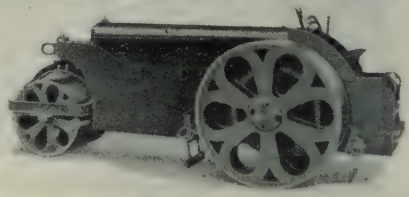
The Turbine Air Concrete Surfacer weighs only 10 pounds. The motor is a true turbine, air driven and revolving on ball bearings. As much as 2,100 sq. ft. of concrete surface has been finished by one man with this machine in a single 8 hours.

How to Make Lime Set Quickly

Some months ago, the U. S. Bureau of Standards developed a quick-setting lime composed of 1 volume of ground quicklime and 2 volumes of hydrate. The commercial success of this material depends upon finding some way to make it keep during shipment, or else to make it into finished form at the factory. Working on this latter phase of the subject, the Bureau has been developing a cast lime partition tile. Experiments have shown the best composition to be 1 volume of wood fiber, 5 of quicklime, and 10 of hydrate; and that the best curing condition is outdoors exposed to the weather. According to a Technical News Bulletin of the Bureau, such a block sets so that it can be removed from the mold in 10 minutes, can be handled in 20 minutes, can be sawed and nailed, and has a compressive strength of 100 lbs. per square inch at 7 days. It is about 20 per cent heavier than gypsum tile of the same size, and experiments are now being conducted to see if the core volume can be increased without too great a sacrifice of strength.

Motor Road Roller

The motor roller brought out this year by the Huber Manufacturing Co., Marion, O., is illustrated below. The main frame of this roller is made of two deep, continuous sections of heavy boiler plate extending the entire length of the roller, tied together with heavy angle iron sections securely riveted in place. The rear axle and cross shaft housings are machined at the ends to exactly fit between the boiler plate sides and are bolted in to add further rigidity to the frame. The rear rolls are made of a single semi-steel casting with hardened face properly beveled to fit the crown of the

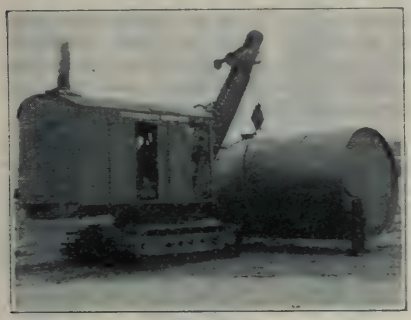


Huber Motor Roller.

road. They have a 20-in. face and a diameter of 69 in. The front rolls have a diameter of 244 in., two sections, giving a total width of 740 in. The gears provide for two speeds forward and two speeds reverse. The travel in reverse is at the same rate as the forward travel in each speed. The speeds are 1½ miles per hour in low and 3 miles per hour in high at normal engine speed. The roller is steered through a segment gear housed in the front end of the frame. The engine is a Huber-Midwest heavy duty 4-cylinder water cooled, developing 45 to 50 hp. The roller weighs 20,000 lb., has an extreme width of 72 in., an extreme length including scarifier of 221 in., and an extreme length of 786 in. Its turning radius is 13 ft., inside circle.

Unusual Method of Moving Steel Tank

A gasoline filling station recently erected offered quite a problem to the contractor. The station was to be equipped with a 15,000 gal. steel storage tank, but since the station was about ¼-mile from the nearest railroad spur, the contractor was confronted with the necessity of finding some means of moving the tank that would be both cheap and quick. The tank weighed better than 5½ tons,



Moving a Steel Tank with a Steam Shovel.

and was about 25 ft. long and 9 ft. in diameter.

Finally, a nearby steam shovel, an Osgood "29" was secured for the job. The dipper and dipper handle was removed and a chain cradle placed around the tank, was made fast to the sheave block. The steam shovel easily lifted the tank clear of the ground and with a man walking either end of the tank to prevent undue swinging, it was carried across a field about ¼ mile, and placed in a 12-ft. excavation. The entire operation required a total time of less than one hour. The continuous treads on the shovel made movement across lots possible with a considerable saving in time.

Tests Point Way to Safer Elevators

About three-fourths of all fatal elevator accidents are found to occur at the hoistway door, either because of the door being opened when the elevator is not there or because of the elevator starting when the door is open. These accidents can be prevented by a reliable interlock, as when such a device is used the elevator must be stopped at the floor before the door can be opened, and the door must be closed before the car can be started again.

During the past year the U. S. Bureau of Standards has been conducting tests to determine the reliability of the various types now on the market. The devices have been given endurance tests under normal conditions, they have been tested in a corrosive atmosphere, in a dust laden atmosphere, with lubrication, and under conditions of misalignment likely to occur in practice.

The tests were conducted at the request of the city of Baltimore, and will permit city governments to base their approval of such devices on actual performance tests instead of on visual inspection alone. The results have also been made available to the manufacturers of the devices tested, and in most cases they have improved their designs in accordance with the suggestions offered.

Wagon for Hauling Light, Bulky Rubbish

A light weight, large capacity wooden-bed wagon intended for hauling leaves, paper, ashes, weeds, tin cans and similar light, dry, bulky refuse is illustrated. The wagon is built in two sizes: a 3 cu. yd. capacity, weighing 2,500 lb., for haulage by one horse, and a 5 cu. yd. capacity, weigh-

Light Weight Rubbish Wagon.

ing 2,700 lb., for haulage by two horses. It is claimed these wagons will hold as much in bulk as three ordinary dump wagons. The wagon bed hangs low, making it easy to load. It also is easily dumped. The wagon can be used as a trailer to a truck by changing poles. This wagon is a product of Geo. H. Holzbog & Bro., Jeffersonville, Ind.

Machine for Removing Shale From Sand and Gravel

A machine for eliminating shale, rotten rock and other impurities from sand or gravel has been placed on the market by the Lansrud Manufacturing Co., Des Moines, Ia. The machine is built of heavy wrought iron. The sand and gravel are passed through it before being elevated to the loading bins. It is claimed that the machine

Lansrud Shale Remover.

can be adjusted so that the percentage of foreign matter can be cut down just as low as desired—even to the fraction of one percent. One advantage claimed is that the percentage of foreign matter originally in the sand and gravel does not vary the effectiveness of the sand remover to the slightest degree. Whether the percentage of foreign matter is blow 5 percent or btween 20 and 30 percent, the machine gets it out.

Forest Products Laboratory Course on Use of Wood as Building Material

The U. S. Forest Products Laboratory, Madison, Wis., which since 1919 has been giving demonstration courses in kiln drying of lumber, boxing and crating, gluing of wood, and wood properties, announces a new course covering wood as a building material. This course is designed for architects, construction engineers, contractors, and others interested in the use of wood in building construction.

The subject matter will be presented in lectures and demonstrations by the experts of the laboratory, many of whom are well known to the building trade. The course will include some of the subjects that have been presented in the kiln drying, gluing and other courses, which have been attended by hundreds of men from all parts of the country. In addition, the new course will take up the properties and uses of various species of woods in building construction; methods of determining the strength of wood; safe working stresses for structural timbers; effect of varying dimensions and of form of beam and joist on strength; decay in wood, its effect and methods of prevention; grading rules; moisture-resistant coatings; and fire prevention in wood construction.

The course for architects will be given at Madison Dec. 10 to 15, inclusive. A co-operative fee of $100 per man will be charged to cover the cost of instruction. Further information in regard to the course may be obtained from the Director, Forest Products Laboratory, Madison, Wis.

Comparative Costs of Maintaining Horses and Motor Vehicles at St. Louis Water Works

The Water Department of St. Louis, Mo., during the fiscal year ending April 9, 1923, maintained 35 horses and wagons, and 22 motor vehicles. The cost of this maintenance is summarized as follows in the recently issued annual report of Edward E. Wall, Water Commissioner:

Cost of Maintaining 35 Horses and Wagons for the Fiscal Year

Repairing wagons	$ 1,845.65
Shoeing 35 horses	2,930.90
Harness repairs and supplies	963.45
Clipping, veterinary and stable expense	223.45
Feed and bedding for 35 head	4,705.29
Total	$10,668.74
Annual cost per one horse unit	$ 304.82

Cost of Maintaining 22 Machines—16 Fords, 1 Dodge, 5 Trucks, for the Fiscal Year

Garage labor	$ 4,781.60
Auto supplies	2,549.92
Outside repairs	313.79
Gasoline, Jan. 15 to April 1	411.40
Oil, Jan. 1 to April 1	98.80
Total	$ 8,155.51
Annual cost per machine	$ 370.70

These comparative costs, states the report, seem to justify the policy of the Department in replacing horses with motor wherever the work will permit.

Tar Wagon with Welded Kettle

The accompanying illustration shows the 4-wheel tar wagon manufactured by the Jos. Honhorst Co., 1016 W. Sixth St., Cincinnati, O. The style illustrated is built in sizes from 250 to 900 gal. capacity. The latest and most important change in this style made during the last year is the welding of the joints in this kettle instead of riveting. This eliminates leaks from loose rivets, prevents tar

Four Wheel Tar Wagon

from accumulating in the seams, and gives the kettle a perfectly smooth interior, which is absolutely tight and leak proof. The kettle is made of heavy ¼ in. boiler steel throughout. The firebox extends under half the length of the kettle bottom and is lined with ⅜ in. locomotive firebox steel. The running gear has heavy front and rear axle castings, made of special steel. The wheels are all steel, with staggered spokes, and tires shrunk over and riveted.

Night Courses in Building Trades at Carnegie Tech

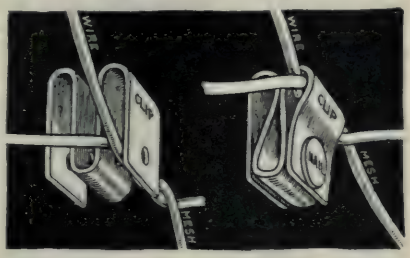
Of the 1,200 night students enrolled for the present year in the College of Industries, at Carnegie Institute of Technology, Pittsburgh, 50 per cent have signed to take course in the building trades.

The courses in carpentry and in electrical equipment and construction report the heaviest gains especially in new students. Of the sixty or more carpentry students enrolled up to a few days ago, more than 40 were new students, while the department of electrical equipment and construction enrolled more than 60 new, and more than 50 former students. The reason for the heavy enrollment of would-be electricians and carpenters this year is attributed by Carnegie Tech authorities to the high wage scales at present in force in these branches of work. Another reason, somewhat indirectly responsible but nevertheless noticeable, is due to the growing interest that labor unions are showing in educational facilities for their respective apprentices. A striking example of this attitude by the unions was revealed in the recent action of the local union of the International Wood-Wire and Sheet Metal Lathers Union which, on its own initiative, has effected a working agreement with Carnegie Tech to train apprentices of this trade. As a result of this agreement, about 15 apprentices attached to the local sheet metal lathers union have enrolled at the Institute, and are compelled by the union to attend a special night course three nights a week for the next two years.

While the action of the sheet metal lathers is the only official agreement that has been announced by the Institute, several other unions in the allied building trades have taken steps to require night school attendance of their respective apprentices.

Furring Clip for Wire Mesh

The accompanying illustration shows a simple furring clip for holding wire mesh at the proper distance

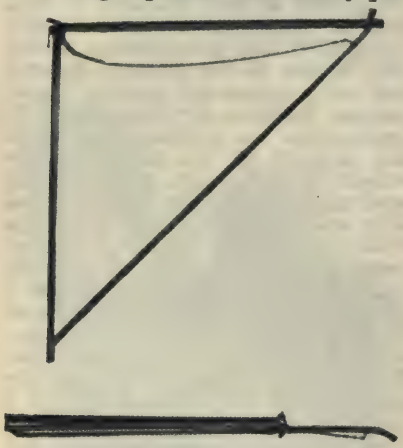


Furring Clip.

from surfaces to be plastered or covered with stucco. The clip is made of galvanized metal. It is hung over the wire and fastened with a 4-penny nail. The clip is made by the G. L. W. Manufacturing Co., San Diego, Calif.

All Steel Scaffold Bracket

A "quick set" scaffold bracket made by the J. L. Austin Manufacturing Co., Menomonee Falls, Wis., is illustrated. The features of this bracket include the following: Two pieces of angle iron riveted together spaced 4 ft. in length pierced with safety per-



Scaffold Bracket.

forations. A lock link chain to tighten steel hook firmly. Cast steel hook which fastens on sheathing. Two pieces perpendicular angle iron 4 ft. in length with two perforations at bottom to prevent side swing. Angle iron at top of perpendicular. Also used to prevent side swing, giving a double "safety check. Tee iron which gives rigidity and locks safety hook. The bracket weighs approximately 19 lb. The upper cut of the illustration shows the bracket extended ready for use; and the lower shows the bracket folded up.

Colored Concrete Hardener

An integral colored hardener for concrete floors, known as "Colormix," that is claimed to contribute in one operation the properties of color, hardness, waterproofness and uniformity, is made by the Master Master Builders Co., Cleveland, O. The product is marketed as a paste with about the consistency of white lead. When put into use it is dissolved in the gauging water, where it dyes every particle of sand and cement of the floor topping a deep, rich color. It is stated the coloring, waterproofing and hardening functions are not limited merely to the surface of the floor, but act uniformly and evenly throughout the entire topping layer. The compound hardens and colors the upper ½ to ¾ in. of the floor. Six colors are available: tile red, linoleum brown, nile green, battleship gray, buff and white. Combinations of these colors may be laid in a variety of designs to fit any decorative scheme. When the colormix floor is troweled it is ordinarily cut into squares to resemble tile, the size of the blocks varying from 6 in. to 18 in. square to suit the tastes of the owner and his architect.

Cost of Spray Painting on Railroad Work

The following figures from the August issue of Railway Engineering and Maintenance show the cost of spray painting on two jobs for railroads.

Cost of painting a 50,000-gal. tub on four 20-ft. latticed columns:

92 hr. at 54c	$49.68
20 gal. Paint at $2.25	45.00
4 gal. Linseed Oil	4.00
4 gal. Graphite Paint	6.00
6 gal. Gasoline	1.50
	$106.18

Cost of painting the girders only of a 1,310-ft. viaduct, (three lines girders about 6 ft. deep, making a total of 47,000 sq. ft.):

First Coat—	
Labor, 338 hr. at 64c	$248.32
Paint, 355 gal. at $1.50	532.50
Gasoline, 57 gal. at 25c	14.25
	$795.07
Second Coat—	
Labor, 221 hr. at 64c	$135.68
Paint, 239 gal. at $1.50	358.50
Gasoline, 37 gal. at 25c	9.25
	$503.43
Labor per 100 sq. ft. for 2 coats—1.27 hr. at 64c	$ .82
Paint per 100 sq. ft. for 2 coats—1.26 gal. at $1.50	1.89
Total	$2.71

A Trolley Operated Mixer

In paving street car tracks on Market St., San Francisco, the Market Street Rys. have been using a concrete mixer equipped with flanged wheels and a trolley pole, so that it can travel along the track by its own power, states Successful Methods. The mixer operates on one of the two tracks while pouring the pavement base for the other track. Current for the electric motor on the mixer is obtained from the trolley wire just as on a street car. The same electric motor that drives the mixer along the tracks also operates the mixing drum.

Night Lighting by Acetylene Flares

At this season of the year, when days are short and owners are anxious for completion of work, the night shift becomes a very important factor in the success or failure of a job. By taking advantage of the night shift, progressive contractors are securing work against their competitors, in view of better estimates and better records of completion. They are also getting greater profits out of their work by utilizing expensive plants throughout two or more shifts per day.

8,000 C. P. Acetylene Flare.

In order to get the best results from night work by eliminating delays to men and machines, it is essential that the work be well lighted. One form of light that is now used all over the country and which is giving good service is the portable acetylene flare light. The accompanying illustration shows one of the acetylene flares made by the Alexander Milburn Co., 1420 West Baltimore St., Baltimore, Md. This is an 8,000 c.p. light, is 6 ft. high, weighs 150 lb., and is equipped with handles so that it may be carried from place to place without difficulty. It is stated to burn for 12 hours on 8 lb. of carbide.

The principle of operation of these lights is as follows: When calcium carbide and water are combined, a combustible gas called acetylene is generated. Calcium carbide, usually called carbide, comes in several forms. The form most generally used is ordinary commercial carbide in lumps 2 in. by ½ in. in size, as this size yields the greatest number of cubic feet of gas per pound, and is obtainable everywhere. One pound of lump carbide gives 4.84 cu. ft. of gas, and the average cost of lump carbide is 5c, making the cost of the gas about 1c a cu. ft.

The charging and lighting are easily performed by unskilled labor. The carbide is placed in a carbide holder containing a series of conical-shaped pockets. This holder fits into a gas bell slightly larger, there being only enough space between the two to form a gas chamber. These in turn are placed in a square tank which forms the base of the light and is filled with water. The water acts on the carbide, immediately generating a gas in the chamber, which rises through an inverted "U" pipe, travels down through a gas washer in the base and thence up through the feed pipe to the burner.

The sludge or slaked carbide is easily removed from the conical pockets by taking out the carbide holder and dumping. The water in the tank need not be changed. The standpipe, burner and reflector are not handled.

The brilliancy of the light is assured by the relatively large water supply in the square tank. The water column automatically maintains a steady flow of gas at the burner without any attention whatever. As the internal pressure within the light can never exceed the water column, a large factor of safety is assured. When the light is turned off, the increased pressure of the gas automatically forces the water from the carbide chamber, preventing any generation while the light is out. This not only insures safety, but makes the light ready for use at all times. When fully charged, these lights will burn

from 10 to 12 hours with practically no care.

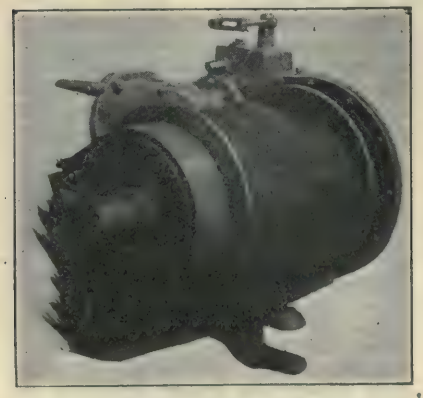
The lights come in various styles and sizes, ranging from the small hand lamp to the large multiple burner type. The flares made by Milburn Company have an excellent device for cleaning the burner, as it pushes the obstruction out of the burner. By means of swivel joints the light may be swung in a complete circle either horizontally or vertically. The reflectors are attached with a reflector holder which can be put on or off while the light is burning, and is of the movable form type, making it possible to spread the light over a wide area or concentrate it upon the work at hand.

The acetylene flare light has been used for years by many of the largest contractors and has been found very satisfactory.

Some of its applications are in tunnel work, concrete-lining tunnels, for drill runners, in excavation work, for steam rock drills loosening up material for scrapers next day, on revolving shovels, grading, pile driving, unloading material for concrete mixers, in railway yards during late afternoon work, electric line repair work, on buildings for carpenters, and installing machinery.

New Tractor Winch

A hoisting drum or winch, which will attach to and be an integral part of a tractor, is now being made by



New Winch for Attachment to Tractor.

the C. L. Best Tractor Co., San Leandro, Calif. It can be attached to any "Sixty." It has a capacity of 300 ft. of ⅝ in. cable and a winding speed of 2½ m.p.h. There is a gear box built into it for disengaging the drum for unwinding and a brake to control the running-out speed. The entire installation weighs 1,550 lb., and does not interfere with the other uses of the tractor on which it is installed.

Crane Mounted on Electric Truck

The accompanying illustration shows what is believed to be the first electric motor truck mounted crane to be used in highway construction.

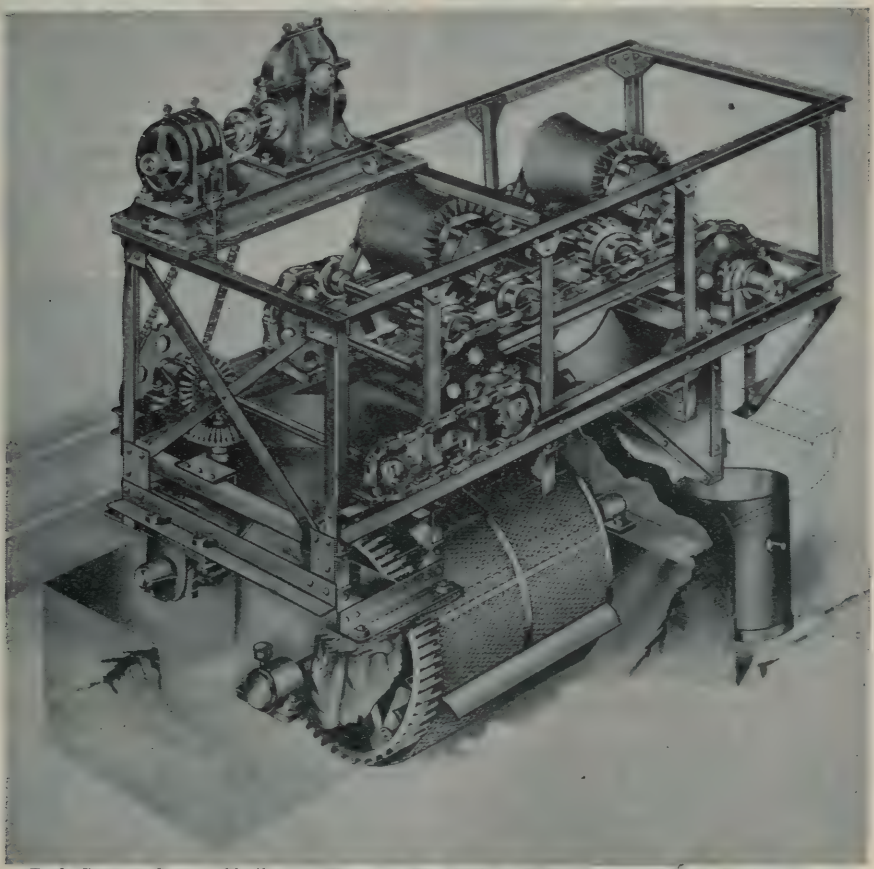
The crane is a Universal made by the Universal Crane Co., Elyria, O. It is powered by a 40 h.p. heavy duty gasoline engine and is equipped with 28 ft. boom and clamshell bucket drums. The crane is mounted on a

Universal Crane Mounted on Electric Truck Unloading Sand and Stone from Railroad Cars to Storage Bins.

Lansden electric truck and does not require outriggers to handle its rated loads. The unit is unloading sand and stone from cars to a Blaw-Knox storage bin. To raise the crane operator so that he can look into the car, which he is unloading, a platform about 3 ft. 6 in. high with a ramp at either end has been built from old ties and filled with cinders. This has helped to facilitate the cleaning up of cars and has resulted in faster unloading. The unit is owned by The Crane Service Co., Newark, N. J. who rented it to the contractor.

Tark Sewage Screen

A recent development in the screening of municipal and industrial sewage is the Tark screen, a product of the Link Belt Co., Chicago. As will be seen from the accompanying illustration each screen is a self-contained unit consisting of a rotating drum (carrying the screen plates), a number of revolving brushes which constantly sweep the surface of the screen (permitting the use of extremely fine apertures without danger of clogging), and motor and reducing gears mounted on a steel frame which extends across the influent channel above the drum. The drum itself is installed in the influent channel across the line of sewage flow. The liquid portion of the sewage after flowing through the apertures in the screen plates passes through one end of the drum into the effluent channel, while the intercepted solids are swept from the outside surface of the drum into a sludge bucket, or mechanical conveyor, by the revolving brushes previously referred to. At intervals in the drum, slots are left between the screen plates from which curved metal "fins" protrude. These "sludge-reclaiming plates," as they are called, serve to scoop up sediment from the bottom of the influent channel, as well as the scum that accumulates on the surface of the sewage, and carries all such debris up to the brushes which sweep it away. A cam mechanism automatically retracts the sludge reclaiming plates to a position within the drum as they approach the brushes. The drum is built up of small curved sections of perforated plates, each of which can be easily



Tark Sewage Screen Similar to Those to Be Used in Milwaukee Activated Sludge Sewage Disposal Plant

handled by one man, and all parts of the apparatus are in plain sight and easily accessible for inspection and adjustment.

Combination Road and Street Maintainer

A combination tractor-scarifier-grader-roller, weighing over 16,000 lb., and powered with a 50 h.p. motor, is illustrated. This machine is designed especially to rebuild unpaved streets and roads and restore them to first-class condition, regardless of the extent to which they have been neglected or damaged. Ordinarily, there are four steps in the process of reconstructing a highway with this machine. The first step accomplishes a scarification of the material to a depth of several inches. The purpose of this is to remove all lumps and humps and to tear out sub-surface "basins" in which moisture accumulates. Step No. 2, crushes the scarified material, breaking up the large chunks and pulverizing the material. Then follows the third step in which the grader blades out the material, shapes the crown and shoulders and surfaces the road according to the specifications followed. The final step is the rolling wherein the roller packs the road or street. The machine is narrow enough to work between car-tracks. The tractor unit is driven by a wide drum roller with power transmitted by chain drive from a 50 h.p. Waukesha motor. There are two speeds forward and one reverse—forward 2.94 and 2.27 miles per hour; reverse, 2.27 miles per hour. The machine drives like an automobile with foot pedal clutch, hand lever brake, gear shift lever, spark and throttle. The scarifier block is equipped for seven extra-long teeth and is raised and lowered by means of a hand wheel and pedestal which is operated by the tractor operator. The grader attaches and detaches instantly. It has a single piece channel frame and all solid connections are hot riveted. It has a special quick-lift device for raising and lowering the blade instantly to avoid obstructions, crossing, manholes, etc. A hand lever operates this quicklift. Blade adjustments are made by means of hand wheels; the blade is adjustable as to pitch, angle of cut, depth of cut and may be swung to either side of the frame. The rear axle is adjustable laterally and pivotally. All wearing parts are made of specially selected materials, carefully finished. The entire outfit is built to give steady and dependable service. It requires but two men to operate the entire outfit—one man operating the tractor, scarifier and roller, and the second man operating the grader. The machine is known as the Gray Giant. It is made by the Gray Tractor Co., Minneapolis, Minn.

Working a Road with the Gray Giant Combination Machine.

Wiring for Electrical Appliances

Data on Typical New York Buildings Given in The Architectural Forum

By WILLIAM H. WHITTON

A subject that still seems to remain largely in the realm of conjecture, even among the central stations that are supplying the electrical service, is the extent to which provision should be made in residential structures, whether apartments or private houses, for the use by the occupants of the various forms of electrical appliances without which, we are about ready to believe, no home is complete. Involved in it are not only the questions of the number and location of outlets—"convenience outlets" is the latest term—to which the appliances may be attached, but that of the capacity of the wiring supplying them, and of the service cables from the street.

That the latter considerations are important may be gathered from the fact, which will perhaps be surprising to many, that it is of quite frequent occurrence in apartment buildings of certain types of occupancy to find that the total load of the household appliances is equal to either the lighting or the power installation of the building, and that in extreme cases it may even exceed the two combined. Fortunately for the wiring in some of the buildings in which this condition prevails, particularly the older ones, the variety of the electrical devices in use, coupled with the natural irregularity in the time of their operation, creates a high diversity factor, spreading the load demands fairly well over the entire day. A certain proportion of the appliances may be expected, however, to be in service during the hours of maximum lighting requirements, and due provision for this condition should be made in planning the wiring capacities of new structures.

Electrical Appliances of Three New York Hotels.—Data have been obtained on the subject in a numer of typical New York residential buildings, a review of which may be helpful in estimating the probable load requirements of household equipment and in planning an adequate number of convenience outlets, although the rapidly growing popularity of electrical devices of all kinds may set at defiance even the most carefully prepared estimates. A list of the appliances counted in three typical apartment hotels, and included here, will give a better idea of the extent to which this condition prevails than can any general description. The buildings in question are of the usual high class found on New York's upper west side, and can be considered as fairly representative of their type.

Cooking Equipment Most Important Item.—Despite the wide variety of utensils listed, it will at once be observed that cooking equipment, both numerically and in the sense of power requirements, is the most important classification. For instance, in Hotel No. 1 we find that in addition to a large number of smaller cooking

HOTEL No. 1

	Appliance	Wattage
25	Percolators	10,000
12	Toasters	6,000
4	Heaters	2,640
85	Grills	56,100
5	Stoves	7,500
2	16-in. fans	150
32	Irons	18,525
4	Vacuum cleaners	946
3	Dental drills	360
3	Dental sterilizers	1,800
3	Victrolas	561
1	Dental converter	120
1	Curling iron	15
1	Heating pad	15
3	Sewing machines	323
1	Moving pic. mch.	47
1	Emery wheel (1 1-6 h.p.)	124
2	Dental wheels (1-8 h.p.)	186
1	X-ray machine	5,868
1	Player piano	187
190		111,567

HOTEL No. 2

	Appliance	Wattage
14	Percolators	5,946
4	Toasters	2,175
1	Heater	550
23	Grills	15,016
20	Stoves	10,786
69	Fans	3,810
30	Irons	16,026
2	Telautographs	150
3	Vacuum cleaners	300
1	Vibrator	40
1	Massage machine	35
1	Hair dryer	35
3	Curling irons	86
1	Sewing machine	87
1	Hotplate	1,306
174		56,298

HOTEL No. 3

	Appliance	Wattage
23	Percolators	13,435
18	Toasters	9,765
4	Heaters	2,600
36	Grills	20,450
38	Stoves	68,716
1	Fan	60
42	Irons	22,435
1	Vibrator	24
2	Sterilizers	1,200
1	Egg boiler	600
2	Hair dryers	380
1	Violet ray mch.	50
3	Hair curlers	160
1	Waffle iron	600
9	Hotplates	5,224
3	Ovens	2,670
1	Heating pad	50
186		148,419

articles, there are five stoves requiring 7,500 watts, or 1,500 watts per stove, and in Hotel No. 3, 38 stoves requiring 68,716 watts, or 1,808 watts per stove. Second in importance to the cooking implements is the electric iron. As in the case of small stoves and grills of a capacity of 660 watts or less, terminals for flexible cords are provided, and it is then left to the purchasers to connect them to whatever lamp sockets or convenience outlets there may be in the apartments or in the particular rooms in which they are used. An outlet is of course very much better adapted for the purpose than a lamp socket, especially if provision has been made for utility outlets having more than ordinarily heavy wire, but if a proper outlet is not conveniently situated, then the lamp socket is naturally pressed into service. The remedy, of course, is to add more outlets, but although not a difficult thing to have done, for many reasons it is usually simpler to tolerate the evil. In a large sense, the problem is one that demands preventive measures rather than remedies.

Voltage Regulation and Appliance Loads.—To just what extent voltage regulation is affected by the appliance loads in buildings in which their use has increased to such an unexpected extent depends, of course, on the amount of copper provided for the main and branch wiring, the number of outlets per circuit, and the extent of coincidence in the use of the appliances. Even one 600-watt device connected to a lightly wired circuit may occasion a sufficient drop in the voltage to cause a perceptible dimming of any lamps burning on the same circuit. It is quite usual, in planning wiring layouts, to assume an average load intensity of from 50 to 55 watts per socket or outlet. In Hotel No. 1 there are 453 convenience outlets, which at 50 watts each would provide for a load of 22,650 watts. Compared with this is the total appliance capacity of 111,567 watts, or a possible load of almost five times as great as the wiring presumably was designed for. Of course it is not to be expected that all of the equipment will be in service at the same time, but on the other hand the load will undoubtedly grow from year to year, and it is to be expected that presently the normal wiring capacity will be absorbed, leaving no margin with which to carry the additional appliances, or the many floor or table lamps which are supplied from baseboard or wall outlets.

In Hotel No. 2, which is more modern by a number of years than No. 1, the outlet provision is much more ample, there being 770 outlets, representing a normal capacity of 38,500 watts. The appliance load at its maximum could be 56,298 watts, which is only about 44 per cent greater than the outlet rating. In Hotel No. 3, which is approximately of the same age as No. 2, a much less favorable showing is made. The normal capacity of the 385 outlets, 19,250 watts, must suffice for a possible load of 148,419 watts, which is almost eight times the outlet rating.

Comparison of Lighting, Appliance and Power Installations.—The comparison of the lighting, appliance and power installations of these three buildings may be of interest, more especially the relative values of the two first mentioned, since they are depndent for their current supply on the same set of building risers. The unexpected prominence of the appliance as a serious factor in determining load conditions will be apparent from these figures:

	Hotel No. 1		Hotel No. 2		Hotel No. 3	
	Watts	Percentage of Total	Watts	Percentage of Total	Watts	Percentage of Total
Lighting installations	64,765	29	70,360	37	120,225	30
Power installations	50,541	22	61,265	33	135,026	33
Appliance installations	111,567	49	56,099	30	151,403	37
Total	226,873	100	187,724	100	406,654	100

In housekeeping apartments and residences the conditions differ in respects from those existing in apartment hotels. Observations of the appliance situation were made in a very large number—running into the thousands—of electrically served residential properties representing practically all scales of living. The outstanding features are the almost universal prevalence of use of electrical articles of one kind or another, and the serious inadequacy of the provision made for their proper use, it

being necessary, in far more instances than the bare figures indicate, to connect the appliances to lamp sockets—an unsightly, inconvenient, and in some instances hazardous method.

Appliance Situation in Apartments and Residences.—Of the total number of premises surveyed, 69 per cent have at least one electrical device in more or less regular use. There are, however, only 26 per cent of the premises which are equipped with convenience outlets of any sort—baseboard, wall or floor—and it is a fairly safe assumption that the outlets have in many instances been so sparingly provided as largely to fail in meeting the requirements of location and accessibility.

Owing to the much smaller number of cooking utensils, the question of wiring adequacy in non-housekeeping residential property is less of a problem than in the housekeeping type, but the very general use of electric irons calls attention to the desirability of making practically 100 per cent provision for the use of these articles. Irons account for 60 per cent of the entire number of appliances recorded, and owing to their relatively high power requirements, for a very much higher proportion of the electrical load. Next in order, numerically, come vacuum cleaners, followed by toasters, percolators and heaters. The actual figures in a number of typical apartment houses are here.

In Elevator Apartment No. 1, there are 162 convenience outlets and 1,633 lighting sockets, in 64 apartments, the occupants of which use 124 appliances, requiring power totaling 47,525 watts. The number of portable lamps attached to outlets is not recorded, but making some allowance for this purpose, it seems clear that many of the tenants must be inconvenienced by a scarcity of outlets, for in the majority of instances an outlet, to be properly useful, must not be many feet removed from the spot at which the appliance is to be used. A heater which can only be connected in the dining room will hardly serve to remove the chill in the bathroom, nor will an outlet in the drawing room prove very helpful when the problem is the serious one of energizing the family curling iron.

The figure of about 2½ outlets per apartment prevailing in this building, is fairly representative of the usual but moderately high priced apartment, but is very much higher than the average throughout all classes, which is but slightly more than ½ outlet per apartment. The result of this almost universal lack is seen in the common use of attachment wires dangling from lighting fixtures, a situation which was very happily hit off in Punch some time ago by a cartoonist who pictured a breakfast scene in a prosperous English household. Draped from the ceiling fixture and from a number of wall brackets was shown a bewildering array of flexible cords. Among the complexities of these Jeems, the butler, bearing a tray and a pained expression, was warily making his way, reflecting, meanwhile, on his troubles. "This blessed 'ouse," he meditates, "is so full of modern conveniences that life has become one bloomin' gime of skippin' rope."

HIGH GRADE ELEVATOR APARTMENTS

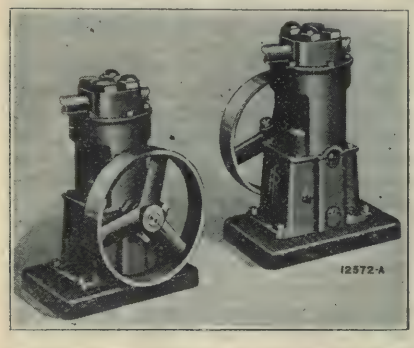
Apartment House No. 1 64 Apartments	Apartment House No. 2 108 Apartments	Apartment House No. 3 25 Apartments
53 Irons	59 Irons	25 Irons
40 Vacuum cleaners	35 Vacuum cleaners	15 Vacuum cleaners
16 Toasters	28 Toasters	9 Toasters
10 Percolators	6 Percolators	5 Percolators
1 Heater	12 Grills	1 Grill
2 Sewing machines	3 Heaters	1 Heater
1 Heating pad	3 Vibrators	1 Heating pad
1 Drill	5 Fans	1 Thermolite
	4 Curling irons	
	2 Heating pads	
	1 Sewing machine	

NON-ELEVATOR APARTMENTS

Apartment House No. 1 5 Apartments	Apartment House No. 2 23 Apartments	Apartment House No. 3 20 Apartments
3 Irons	16 Irons	19 Irons
3 Vacuum cleaners	4 Vacuum cleaners	7 Vacuum cleaners
1 Toaster	4 Toasters	2 Toasters
1 Percolator	1 Percolator	4 Percolators
4 Fans	1 Fan	5 Grills
6 Medical appliances		1 Heater

New Line of Vertical Belt Driven Vacuum Pumps

A new line of small vertical belt driven vacuum pumps has been brought out by the Ingersoll-Rand Co., 11 Broadway, New York. This line of pumps, known as Type 15, will pull and maintain vacuums between 28.6 in. and 29:25 in. depending on their size. In addition to the standard belt design each size is built as a self-contained electric motor outfit, using the short belt drive arrangement or driven through pinion and internal gear.

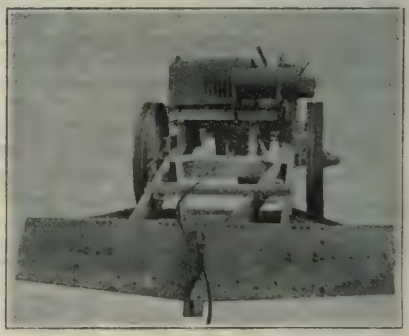


Type 14—5 in. x 3 in. Vacuum Pump, Fly Wheel Side.

The vacuum pump and electric motor of both the short belt and gear driven units are mounted on a metal sub-base, so that they are not dependent on the foundation for correct alignment. The "Constant-Level" system of lubrication used on the Type 15 vacuum pumps maintains a constant-level of oil, which insures the right amount being distributed to all parts. Like in the ordinary splash system, the bottom of the pump base forms an oil reservoir, of sufficient capacity, for the "Constant-Level" system. The amount of oil in this reservoir is determined by high and low level pet cocks. Above the reservoir and directly underneath the connecting rod is a constant level pan, into which the connecting rod dips and distributes just a sufficient quantity of oil for proper lubrication. The constant level pan is replenished with oil from the supply in the crank case by a valveless oil pump operated by an eccentric on the main shaft. Regardless of the amount of oil in the reservoir so long as it is somewhere between the high and low level petcocks, it is stated, this system will function perfectly. There are six sizes—the 4 in. x 2 in.; 5 in. x 3 in.; 6 in. x 4 in. and 8 in. x 5 in. single acting pumps; and 10 in. x 5 in. and 12 in. x 6 in. double acting pumps. The 2 in., 3 in., 4 in. and 5 in. stroke single acting pumps are air cooled by means of an annular ring which encircles the cylinder, while the 5 in. and 6 in. stroke double acting pumps are cooled by means of circulating water.

Self Anchoring Stump Puller

An important feature of the stump puller brought out recently by the Monarch Tractors, Inc., Watertown, Wis., is a self-anchoring device by means of which the puller is anchored without the necessity of tying it to other trees or stumps. The stump puller is carried on a 3 wheel chassis. The front wheel is a small diameter castor wheel which permits very short turns. A large diameter axle passes through the two rear wheels, and supports the heavy steel channel frame, which has the anchor built into the rear end of it and carries the power plant and cable drum at the opposite end. Pivoting the frame over this axle allows the anchor blade to drop down into the ground when pulling, while in hauling the machine over the road the front end of the frame is pulled down to a horizontal



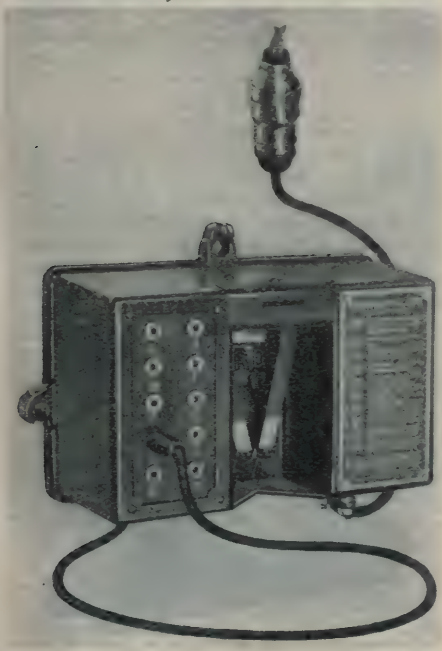
Monarch Self-Anchoring Stump Puller.

position by means of a crank and cable attached to the chassis frame. Practically all of the weight of this machine is so located as to counter-balance the cable pull. Some additional weight is necessary to counter-balance the heaviest pulls. This weight is hung from a boom held in position by guy wires attached to the frame. The boom also serves as a tongue when using horses to move the ma-

chine and is then clamped in place over the short tongue on the castor wheel. The short tongue is fitted with a tractor hitch. The cable drum is driven through a jaw clutch on the large spur gear and is arranged to slide on the drum shaft so that it may be disengaged from the gear and revolve freely when pulling out the cable. A Ford engine, transmission, radiator, etc., make up the power plant. Two forward speeds, reverse and brake are provided.

A Device for Simplifying Heat Treatment of Drill Steel

A device for simplifying the rather technical and complex process of forging and heat treating drill steel has been placed on the market by the Denver Rock Drill Manufacturing Co., Denver, Colo. Drill steel, like other steels, at various temperatures has certain definite colors and drill steel of a given analysis has a corresponding hardening temperature. Hence the problem of finding heat-treating temperatures is obviously, from the blacksmith's standpoint, one of color comparison. This is claimed to be accomplished by the Waugh Comparascope which allows the blacksmith to directly compare the color of the heated drill steel with that of another heated metal having the same color at a given temperature. The Comparascope is rugged throughout in its construction. The body or housing is of heavy metal and is so designed that the instrument can be quickly and easily mounted on a wall or a substantial board placed near the furnace. A convenient length of flexible electric light cord is provided with connection for attaching to a near-by lighting circuit. A small coil of high resistance wire, visible through a lense in the center of the apparatus, is brought up to any desired heat by merely plugging into the corresponding socket at the left hand side; temperatures, carbon content and directions being indicated on the directions plate at the right. The coil has a fixed resistance and is connected in series with a variable resistance which in turn is connected with the various sockets into which the plug is inserted. A transformer inside the case steps the voltage down from 110 or 220, that of standard lighting circuits, to 30 volts, so that danger of shock is eliminated. A high grade permanent magnet is pivotly suspended at the center of the instrument immediately below the radiating coil. Through an opening directly above the coil, the magnet indicator shows the non-magnetic condition of the steel. The magnet is not essential to the correct functioning of the Comparascope but has been added as a convenience and serves an as aid at the hardening temperatures only. There are no parts to get out of order. The resistance or radiating coil is good for several months of constant service and can be very quickly replaced on the binding posts at the back of the lense. The coil is inexpensive—costing only a few cents. When the carbon content of drill steel is known, forging and hardening temperatures are quickly and easily determinable. This is simply done by plugging into the socket having a corresponding carbon content indicated on the directions plate and heating the steel to the same color as the radiating coil. Where the carbon content is not known, the steel should be tested several times with the magnet. A low red heat should be used at first. If the magnet is attracted to the steel, the change point —hardening temperature—has not been reached. This test should be re-

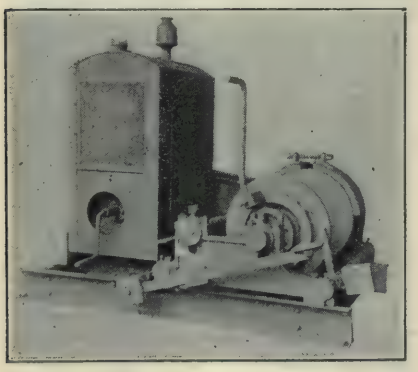


The Waugh Comparascope.

peated, heating the steel a little more each time, until there is no attraction of the magnet. At this point the color of the steel is matched with the radiating coil by trial plugging into the sockets. It is preferable to have the plug in socket "C", 1400° F., when starting test with the magnet, for drill steel having a higher carbon requiring a lower color is seldom used. If socket "C" does not show as high a heat in the coil as there is in the steel, the plug is stepped up to a socket having a higher temperature. Having matched the colors in the manner just described, the carbon content becomes known by the corresponding letter on the directions plate.

Material Elevator Hoist with Multiple Cylinder Engine Power Plant

A hoist unit built expressly to operate a material elevator in building operations is illustrated. It is stated to lift an elevator with ease and

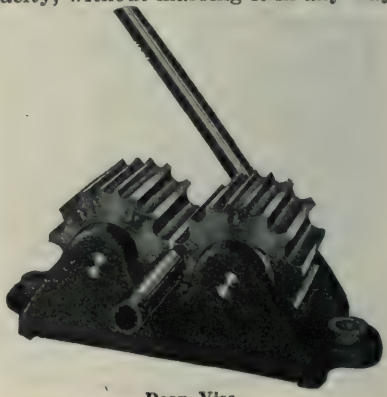


Material Elevator Hoist Unit.

smoothness and to be capable of handling a line load of 1,000 lb. at a hoisting speed of 125 to 188 ft. per minute without any change in gearing. The advantage claimed for this unit include the following: The free running drum of this type of hoist permits the rapid lowering of elevator, even when empty, without wear or tear on engine or gearing. Pawl and dogs hold elevator at any desired elevation while control of lowering is done with band brake on drum controlled by foot lever. For single cage elevators use single drum unit and for two cage elevators the double drum unit. The unit has a perfectly balanced 2-cylinder engine having a speed range of from 800 to 1,200 r.p.m. thus giving a selection of hoisting speeds ranging from 125 to 188 ft. per minute. Engine complete with magneto, radiator and cooling fan, automatic oiling device, and speed control governor, is protected from the weather or petty thieves by metal housing. The hoist has asbestos metallic face on friction cone which is impervious to heat, cold and moisture, and can be renewed when worn. This gives the cone a very high frictional efficiency. As elevator installations for handling building materials are but temporary affairs, there is seldom provided for the hoist unit a firm foundation. To meet this condition this type of hoist unit transmits the power from the engine to the countershaft of hoist by roller chain running over machine cut sprockets. This hoist unit is made by the Domestic Engine & Pump Co., Shippensburg, Penn.

Pipe Vise

The vise illustrated below is now being manufactured by the H. W. Clark Co., Mattoon, Ill. It is known as the Dean vise, and is designed for holding any kind of pipe within its capacity, without marring it in any way.



Dean Vise.

The gripping is accomplished without the aid of teeth. The gripping surfaces of the jaws are as smooth as the pipe to be held, and it is this, together with the fact that the jaws conform exactly to the periphery of the pipe, which allows a tremendous holding strain to be applied. The vise is 11½ in. long, 5½ in. wide and 4⅜ in. high. It weighs 22 lb. It has a capacity for ⅜ in. to 1 in. tubing, ⅛ in. to 1 in. pipe and ⅜ in. to 1 in. rods.

Humus from Garbage

Research Narrative of Engineering Foundation

For generations, men have sought to return to the soil some of the nutriment taken from it. In the main, Man's organic wastes have been lost, especially from communities. Indeed, they have been a nuisance or a menace unless destroyed. Often they have been removed long distances only to pollute streams, harbors or idle land. Science and engineering have offered many methods for disposal of sewage, garbage and other wastes. One of the problems has been to devise simple, inexpensive and safe means suitable for small communities, institutions or single families, yielding an inoffensive and useful product. High cost of fertilizers, caused by the war, gave new impetus to endeavors in some European countries.

A few years ago, an Italian scientist, who had worked on the problem for a long time, Giuseppe Beccari, discovered that in a properly constructed cell of cement concrete or other tight masonry, natural processes of fermentation could be so controlled and expedited as to reduce kitchen wastes, animal carcasses, grass clippings, fallen leaves, stable manure, and human fecal matter to humus without disagreeable odors or other offensive features. No fuel nor chemical is required. Aerobic bacteria do the work. All disease germs of man, beast and plant, all weed seeds and parasites are destroyed. Gustavo Gasparini and other scientists have confirmed by extensive tests the results gotten by Dr. Beccari. The zymothermic cells are in practical use in a number of places in Italy.

After a cell has been filled, the temperature begins to rise on the third day, and in a comparatively brief time attains 140 to 150 deg. F. Maximum temperature, between 150 and 160 deg. is reached about the 10th day, holds nearly constant for 20 days and then falls slowly. Fermentation is complete in from 35 to 45 days, depending on atmospheric conditions and the nature of the wastes. By the 35th to the 45th day, the product is sufficiently cooled to be drawn out to a bin in front of the cell, or other convenient place, where, exposed to sunlight, the excess moisture dries out. The product then resembles loam. Bones, objects of metal and ceramic wares are not affected; they are removed by screening. Of course, it were better to keep them out of the garbage in the beginning, particularly tin cans and broken crockery. Carcasses of animals are reduced to skeletons (entirely free from flesh and cartilage) and a small humid mass. At no time during the process is there odor of putrid flesh.

The inoffensive black humus yielded by the cells may be used as an enricher of the soil, restoring some of the properties taken out by crops. It is a good fertilizer, containing nitrogen, phosphate and potash.

Each cell is an approximately cubical masonry box of from one to 25 cu. yds. capacity, according to requirements of each installation. Larger plants are made by grouping cells in series. Each cell has a double floor, the lower one watertight, and the upper, a concrete grating. Through the outer wall, between the two floors, are air inlets. In the four interior corners are vertical air ducts with openings at regular intervals connected with horizontal air passages formed by ridges on each wall, projecting a few inches. All these air ways, and the space at the top of the cell, over the charge of wastes, connect with a specially constructed ventilation tower surmounting the cell and having openings to the atmosphere. Wastes are put in through an opening in the top of the cell. The product is removed through a large opening in the front wall controlled by a tight door. The liquor from the charge during fermentation is collected by drains from the lower floor into a pit. This liquor contains many of the bacteria of fermentation and is used for wetting new charges so as to assure and expedite the beginning of the process. The exact form and arrangement of the cell was determined by years of experimentation.

Although an outgrowth of the compost heap, common in gardens for centuries, the zymothermic cell is a product of scientific research and engineering design. Success appears to be due in large measure to the arrangement of air passages which distribute air to all parts of the contents of the cell.

Adjustable Shoring—An Economy

The two accompanying illustrations show the general appearance and the locking feature of the Agness Adjustable Shore which has just been placed on the market by The Marsh-Capron Company, Lumber Exchange Building, Chicago.

The locking operation is entirely mechanical and positive. When the pipe extension is lifted up to place, the locking plates automatically grip the pipe and hold it tight.

This shore is intended for setting by one man. Its use is described as follows by its producers.

The workman has no sawing to do, no splicing to do, no heads to spike on. He can easily set two Agness Shores in the time needed to set one ordinary shore.

He carries the Agness Shore to position, and shoves up the pipe extension so that the shore holds itself in place. Then he tie-braces the shores together.

Tie bracing is needed in one direction only. Sheathing strips, placed across the horizontal tie-braces, make a handy scaffold to use when taking down the forms—also act as substantial braces, to prevent shores from weaving in the other direction.

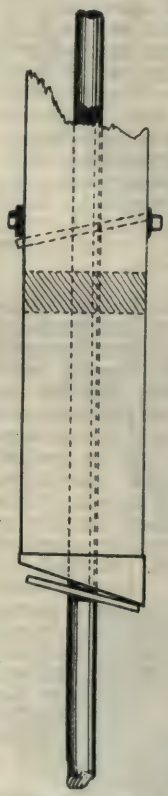
Before the concrete is poured, the extension is raised to the exact height. Any adjustment can be made in the height at any time, without disturbing the tie-bracing.

To make final adjustment, the extension is jacked up with a couple of two-by-fours. For a little extra speed and handiness, the patented Agness Adjustable Shore Jack can be used.

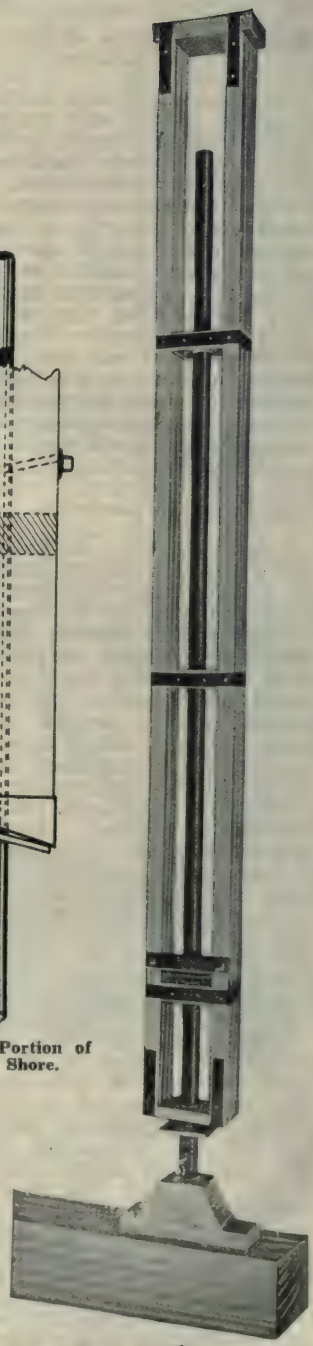
The Agness Adjustable Shore instantly locks itself in place when it is jacked up, and the setting of the shore is complete. No wedges to drive, to adjust shores to height.

The Agness Shore holds its position exactly, until you are ready to take down your form work.

When the concrete is set and you are ready to move the shores to another part of the job, Agness Shores speed up the job again, and save labor cost in dismantling both shores and forms. Men can stand on the sheathing strips that run across the upper tie braces, to strip the form lumber from the under side of the finished concrete. It is easier than working



Locking Portion of Agness Shore.



Agness Shore in Place.

from ladders. No special scaffolding required—saves time and labor.

To unlock the Agness Adjustable Shore, it is only necessary to put a wedge under the top locking plate; any small piece of scrap material will do. This wedge is put in place with one hand in a second or two—no jacking or hammering required.

After placing the wedge, hold the pipe extension with one hand and lift the lower locking plate with a hammer. This releases the shore. The lower part of the shore can now be raised from the floor, and by rocking the shore back and forth once or twice, the nails that hold the head are quickly twisted off.

One man can dismantle Agness shores. The upper lock stays open as long as the top wedge is in place—there is no need to hold the lock open while the shores are being removed.

The Agness shore is estimated to last 150 settings in ordinary service, although there are records of their use for more than 200 times.

A comparison in cost per setting of ordinary wooden shores and Agness shores is as follows:

ORDINARY SHORE

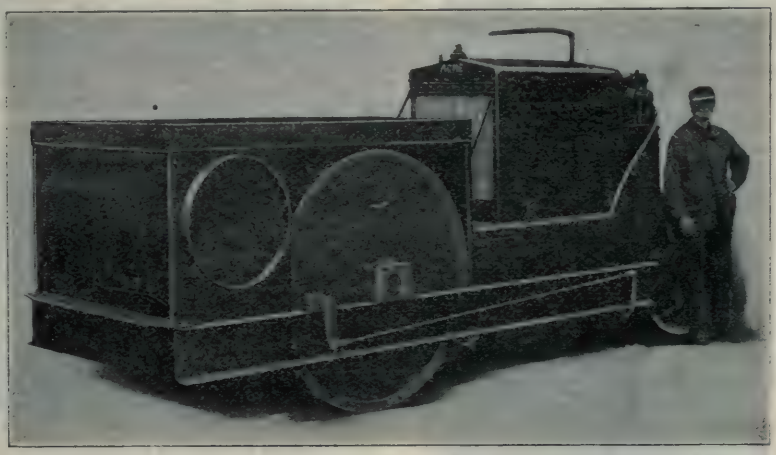
Cost of shore $1.09, used 7 times	$0.15½
Wedges	.04
Labor cost, setting	.10
Reconditioning—material and labor	.28½
Total	$0.58

AGNESS SHORE

Cost of shore $4.95, used 140 times (140 times taken as conservative)	$0.03½
Labor cost, setting	.05
Reconditioning—material and labor	.01
Total	$0.09½

New Tandem 4-Cylinder Gasoline Roller

A 4-cylinder gasoline tandem road roller is the latest contribution of the Acme Road Machinery Co., Frankfort, N. Y. to road building equipment. The power plant on this roller is a Continental Red Seal standard truck motor with electric starter. The transmission gears are all cut steel and all high speed gears run in oil, anti-friction roll and ball bearings are used throughout. This applies even to the rolls which run on Hyatt heavy duty roller bearings. The steering device is operated by power and a hand wheel is also provided. This roller has two speeds, in either direction, and is handled the same as a truck. The clutch and service brakes are operated by foot pedals and the emergency brake by hand lever. Hand levers are provided for shifting gears. The construction of this roller is very rugged, insuring a long life.

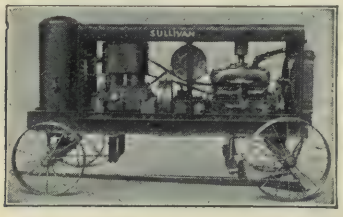


8-Ton Tandem 4-Cylinder Roller.

The advantages claimed for this roller are, dependability, ease and economy of operation, absence of smoke and dirt and pleasing appearance. This roller is made in all sizes from 3 to 8 tons.

Improved Type of Portable Compressor

The portable compressor illustrated below is a recent development of the Sullivan Machinery Co., Chicago. It has a larger capacity than the earlier models, namely 170 cu. ft. of free air per minute. This capacity is ample to operate two rotator drills at full speed on holes to a depth of 14 ft., with 100 lb. air pressure. The compressor is of



Sullivan WK-311 Portable Gas Engine Driven Compressor.

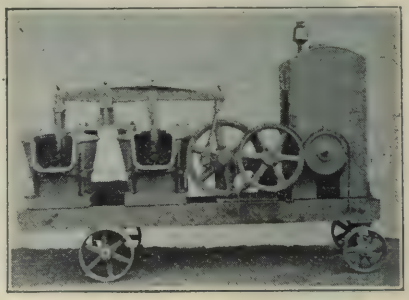
the vertical tyo-cylinder type, single acting, and runs at 450 revolutions. At this speed 31 h.p. is required to produce 80 lb. air pressure. The compressor is operated through reduction gearing by a Buda four-cylinder Class YTU tractor type gasoline engine. The magneto, carburetor and other fittings have been selected for their simplicity and substantial character. The engine is cooled by a fan and radiator of ample size. The engine, com-

Portable Compressor wi h Protecting Covers in Place.

pressor and fittings are mounted on a substantial truck body, strongly braced, to eliminate vibration and wear. Steel axles and heavy broad faced wheels are regularly supplied. Wheels with solid rubber tires can be furnished if needed for use on city pavements. The outfit is protected from the weather by a strongly braced sheet steel top and removable sheet steel sides, which can be locked in place so as to protect the outfit not only from the weather, but from tampering and theft. The gasoline tank holds 23 gal., which is sufficient for a day's run at full load. A vertical air receiver is mounted on the front end of the truck next to the compressor. The net weight of the outfit, empty is 6050 lb. When the outfit is to be towed behind a motor truck it can be furnished on a trailer type of truck with springs and rubber tires, and suitable draw-bar, etc. to adapt it to this service.

Double Diaphragm Pump with Multiple Cylinder Engine Power Plant

A double diaphragm unit designed for use in cofferdam, sewer, ditch and trench work where seepage of water exceeds the capacity of a single pump unit is illustrated. The multiple cy-



Double Diaphragm Pumping Unit.

linder engine provides an even flow of power. It is protected from weather and petty thieves by being enclosed in metal housing, and is of the type engine familiar to automobile mechanics. The two No. 4 Domestic power diaphragm pumps used on this unit have their suction ports connected by a manifold so that one lead of suction pipe or hose only is needed. The alternate action of pumps maintains a constant suction, thus increasing capacity of both pumps. The walking beams raises and lowers the diaphragm in an almost straight line, thereby increasing suction and prolonging life of diaphragms. It is claimed these units will pump from 16,000 to 22,000 gal. of water per hour, actual delivery. This pumping unit made by Domestic Engine & Pump Co., Shippensburg, Penn.

Motor Bus, Trolley Bus and Electric Railway

Co-ordination of Bus and Trackless Transportation With Electric Railway Service Discussed in Paper Presented June 23 Before New York Electric Railway Association

By W. B. POTTER
Railway Engineering Department, General Electric Co.

The past 15 or 20 years have witnessed some remarkable developments and progress in the art of transportation. During this period rolling stock of the electric railways has been developed to a point which enables the street railway to render the most reliable transportation at the lowest fare.

While this development in street railways was in progress, other forms of transportation have been developed which have demonstrated that they have a definite place in the transportation field.

The most conspicuous of these is the automobile and its effect on the public.

Effect of the Automobile.—Privately owned automobiles have demonstrated that when in the hands of independent operators, they are capable of rendering competitive service to established rail lines.

Owing to their small capacity and extreme flexibility, they can provide a faster schedule than the street cars and even though they do not provide the same degree of comfort, they have in many instances been able to offer successful competition. This development made it necessary for the street railways to change well established policies and provide improved service. The light weight one-man car was introduced and on account of its low operating costs enabled the railway companies to provide a more frequent service with no loss in net revenue.

The growing use of the privately owned automobile, however, created a demand on the part of the public for a different kind of service, which manifested itself in two forms. One, the limited demand for a high class service within the densely populated sections, which provided some features not obtainable with the street car, and for which a limited number of persons are willing to pay a higher fare. The other, a demand for transportation in thinly populated sections and from the centers of population to smaller communities, which were without adequate transportation facilities. For this class of service infrequent headways are sufficient, but the public demands the same rate of fare as collected by the railway and to be carried to their destination for a single fare.

Advantages of the Bus.—The result of these demands was the development of the bus, and the adoption of it by the street railways for use in connection with their established rail lines.

With this development there were many advocates of this form of transportation, who claimed that the bus would displace the street railway. Experience, however, has demonstrated that when busses are the only means of transportation, they have failed to provide the service demanded by the public, as they are totally inadequate for mass transportation and for peak loads. Busses have, however, demonstrated that they have a very useful field in providing transportation in thinly populated sections where they are operated as feeders to established rail lines.

There are two types of busses available for this class of service, the motor bus and the trolley bus.

Owing to the low capital investment required, and to its extreme flexibility, the motor bus is making rapid strides for a prominent place in the transportation field. Perhaps the most valuable asset of the motor bus is its flexibility, which makes it possible to meet sudden or temporary needs and to change routes as often or as quickly as desired.

This is of particular advantage when new routes are being established as changes can easily be made to suit the varying conditions.

Another advantage of no less importance is the lower initial expenditure as no investment is required in track, overhead or power station. The cost of operation, however, is materially higher than a rail car or a trolley bus, and even including the fixed charges on the capital invested in

each system, the total operating costs are in many cases greater than either of the other systems. Records from a large number of bus companies show that the average cost, including all charges, except a paving charge, is 33 ct. per bus mile. When taking into consideration the smaller capacity of the bus, requiring approximately 3 times as many busses as cars, during the peak hours, the total cost of operation becomes 50 per cent greater than rail lines.

The economical field of the motor bus, therefore, is where infrequent headways are to be provided and where the lower fixed charges offset the higher operating costs. This field is; in providing service between centers of population and small communities which are without adequate transportation facilities, in establishing feeder lines to existing rail routes, and opening up new territories.

Field of Trolley Bus.—The trolley bus, more recently developed, has a field of application which lies between that of a motor bus and the street car. On account of the overhead wires necessary for its operation the initial expenditure is more than a motor bus installation, and consequently the fixed charges are higher. For the same reason the cost of the vehicle itself is more than the motor bus. This is apparently due to the fact that when the bus is equipped with electricity as a motive power it becomes more nearly a street car and the operators are unwilling to accept the same standard and same body construction they accept in the motor bus.

To offset the higher fixed charges due to initial expenditure, the trolley bus has lower operating costs. Using motive equipment similar to street cars and taking its power from the same source, it has a lower charge for the maintenance and depreciation of the equipment and lower power costs.

Cost of Operation of Trolley Bus.—There are few operating costs available on trolley bus installations. These can, however, be accurately estimated from known cost of electric railway cars and motor busses. Such estimates indicate that the total operating costs including fixed charges are 25 cts. per bus mile. These estimates are borne out by at least one trolley bus installation which has been successful operation for a period of 18 months. The actual cost from this installation including the fixed charges on the capital actually invested is 25 per cent per bus mile.

The flexibility of the trolley bus is not as great as the motor bus, but is greater than the rail car. While it must operate within reasonable distance of its overhead wires, it has no fixed path and can manoeuver in traffic.

Field of Application of Bus and Rail Car.—Where new extensions are to be made; the practical field of application of the motor bus, the trolley bus and rail car can be fairly closely defined. In general, the conclusions which can be derived are as follows:

(A) Where rush hour headways of three minutes or less are required, rail cars are the most economical, and up to six minute headways can offer very successful competition to either type of bus.

(B) On longer headways the trolley bus has the advantage due to lower fixed charges.

(C) The gasoline bus on account of higher operating costs does not offer competition to the rail car until a minimum headway of 10 minutes is reached.

(D) The trolley bus is more economical than the gasoline bus up to headways of 60 minutes.

Where the rail lines are already in existence, the motor bus does not offer serious competition until headways of 20 minutes are reached.

That both motor busses and trolley busses are furnishing an important contribution to the art of transportation is best shown by the fact that a number of important railway companies have adopted busses as auxiliaries to their rail system. Baltimore, Akron, Milwaukee, Louisville, Los Angeles and many others are examples of motor bus installations. Rochester, Minneapolis, Philadelphia, Staten Island, Baltimore, Toronto and Windsor are examples of trolley bus installations.

These installations of busses are enabling railway companies to extend their lines into the suburbs or into new sections of the city at a great saving in investment, and to carry on operation at a great saving in total cost over a track system. As the district grows, the time comes when the service can be more economically given by the railway and the operating company is justified in extending

its rail lines and transferring the bus to still more remote sections.

One point to be given consideration in selecting motor busses or trolley busses is that the vehicle which would best serve the purpose of the street railway industry is that which utilizes partly, if not entirely, the power supply and distributing system available within the street railway organization. By such means existing properties representing large investment can be preserved and applied to much greater activity.

The Engineer and Public Affairs

Extract From Report of Publicity Committee of Iowa Engineering Society

We frequently enjoy having one of our number tell us how much better public affairs would be conducted if engineers were in charge of those affairs. Such discussions always imply that engineers have all the necessary requirements but that some intangible something prevents them from attaining those positions. Has your work or mine, that of the average members of this society, ever been such as would lead anyone to guess that we had those qualities? Your committee believes that, potentially, the engineer has the qualifications necessary to a successful handling of public affairs, but that some of the very necessary of those qualifications are, at this time, only potential. These qualifications exist but they have not been developed nor used. Too many of us are "kidding" ourselves into believing that a desire to hold positions requiring those qualities is equivalent to a certain knowledge that we do possess them. Until engineers choose to develop and use those qualities, this talk of the value of the engineer in charge of public affairs is going to continue to be largely talk.

The question of whether the engineer wishes to step out of the strictly technical field into this broader field seems to be answered, so far as this organization is concerned, by the frequent discussions of these subjects, and your committee felt free to consider it because it is unfair to expect a little publicity work to furnish all the power to operate the elevator to fame and recognition.

What is the outstanding difference, so far as this consideration is concerned, between the doctor, merchant or attorney who gets behind some project of public improvement, and the average engineer? Simply this. The doctor or attorney considers the improvement from a general standpoint as a citizen, while the engineer considers it from the standpoints of materials, stresses and economics. The successful promoter considers the problem in terms and from a viewpoint which the general public can understand; the engineer's terms and viewpoint are so almost wholly "Greek" to the public that they hardly know whether he has considered it at all. So long as the engineer confines his efforts wholly to his technical work as an engineer, the public cannot know much about him.

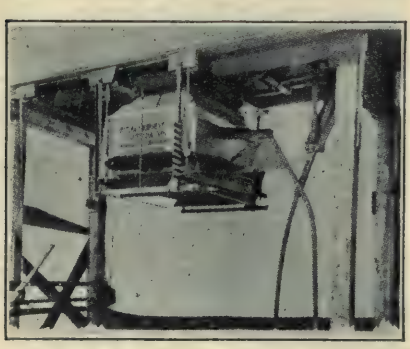
The engineer cannot educate the public to his viewpoint, at the start at least, so if he wishes to put the elevator into operation he must adopt the viewpoint of a citizen and work as a citizen of his community. If he renders this sort of service along with his technical service, the public can and will recognize his value and importance. Publicity is necessary, but it is only one part. When the engineer thinks and talks as engineer-citizen he will recognize more "news stories" in his work, and will do more work that is of itself news. If he continues this development he will soon reach a stage where he will "receive" publicity—he won't have to "get" it.

New Creeper Truck Loader

A new model of the Haiss creeper truck loader has been brought out by the George Haiss Manufacturing Co., Inc., New York City. Improvements and refinements have been made at many points in the machine to give easier operation, greater strength and capacity, and particularly lower upkeep expense. The principles of operation, steel plate feeding propellers, 2 ft. crowding speed, toothed buckets, completely enclosed transmission and clutches, remain the same. The changes consist of improvements, refinements and increased size and strength in detailed parts. One of the machines of the new model is stated to have consistently loaded 6 yd. of 2 in. gravel in 3 minutes, and got out 41 such loads, or 246 yd. on 8 gal. of gasoline. Some idea of the size and power of this machine will be had from its weight of 15,000 lb. and its 37 h. p. Waukesha truck motor power plant.

Adjustable Measuring Hopper

The adjustable measuring hopper shown in the illustration is designed primarily for use in material handling yards. The hopper will measure any volume between 10 and 28 cu. ft. It can be set for 1 cu. yd. and the volume



Butler Type B Adjustable Measuring Hopper.

change to ½ cu. yd., 20 cu. ft. or any volume between maximum and minimum limits by means of the ratchet and windlass arrangement in about 20 seconds time. In other words, material can be measured off by the cubic yard or measured for batch haul in the same measuring device on account of the rapid change of adjustment. This device enables the material yard to load a truck with 2½ cu. yd. in between trucks hauling batches to a paving mixer. It is manufactured by the Butler Equipment Co., Waukesha, Wis.

New Trenching Machine Bucket

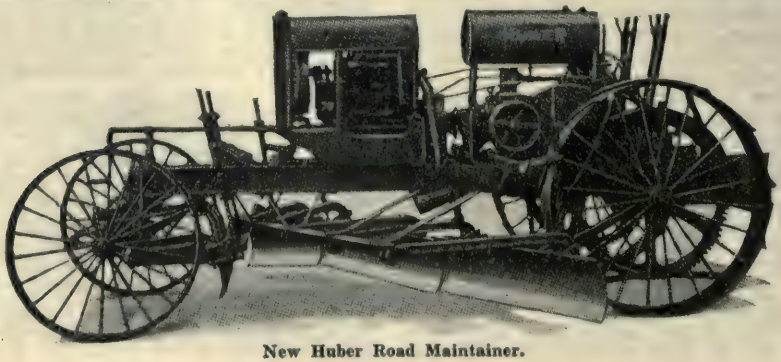
The main feature of the new design of trench machine bucket just brought out by the American Manganese Steel Co., Chicago Heights, Ill., is that the lugs accommodating the digging chain are cast integral with the bucket proper, which provides a lug section that does not depend on rivets to carry the load. Shoulders are provided on the lugs and also on the chain links, and when in operation the

New American Manganese Steel Co.'s Trenching Machine Bucket.

rear end of the bucket lugs bear directly against the inside of the chain links, thus taking all longitudinal or digging strains off the rivets. This bucket was designed at the suggestion of operators to provide a bucket that would stand up under the shock stresses experienced where digging is hard or rock encountered.

New Road Maintainer

A new road maintainer just on the market recently by the Huber Manufacturing Co., Marion, O., is illustrated. This is a heavy machine built for heavy duty. It weighs 4 tons, and is stated to be capable of delivering as much power on the draw bar as a 15-30 tractor, thus making it possible to pull a detached grader for cleaning out ditches, or other road machinery. It is fitted with a power take-off pulley and can be used for operating a stone crusher or other portable belt machinery. The drive wheels are both back of the cutting blade, and the machine has a long wheelbase. The blade is flexible, being made to conform to the contour of the road.



New Huber Road Maintainer.

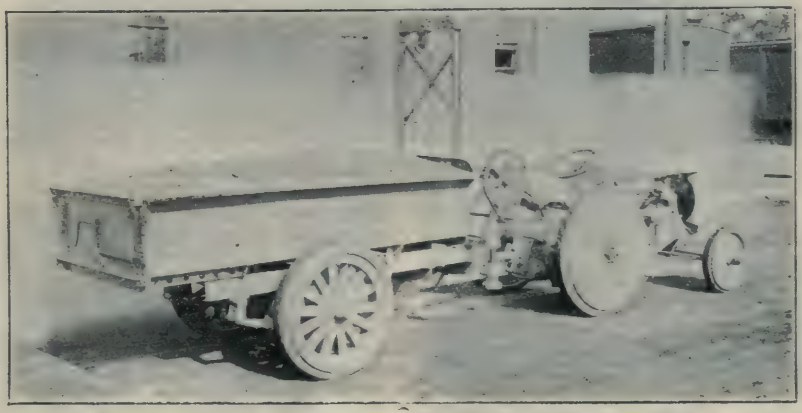
New Quarry Car Has Side Dump

The Koppel Industrial Car & Equipment Co., Koppel, Penn., recently sold to the Elmhurst-Chicago Stone Co., Elmhurst, Ill., sixteen extra heavy type one-way side discharge quarry cars, which are a considerable departure from quarry cars heretofore in use. The dumping, instead of taking place through an end gate, as has been the practice for years, is accomplished through a longitudinal gate, which is swung up and away from the car as the body is raised. This arrangement is claimed to be a decided advantage, in that larger and heavier cars can be used, and the dumping is more gradual than with the end gate car, enabling the crusher to accommodate the stone to better advantage. The cars have a capacity of 5 yd. level full, or about 6 yd. heaped up. They are standard gauge, built of steel throughout, underframes being of the double spring pedestal, outside journal, diamond arch bar type. The structural sections are heavy channels, I-beams and Z-bars. Spring draft gear and a special type cast steel link-and-pin coupler is part of the equipment. The body is further custioned by means of 4 in. x 6 in. oak stringers, of which there are four, placed cross-ways of the car to take the first impact from the shovel. The floor is of a sandwiched type, consisting of 4 in. oak planks between ⅞ in. high carbon plates on the top, and ¼ in. plates underneath. The car is dumped by means of a simple air cylinder and two hooks balanced on an equalizer. These hooks engage a 4 in. angle running the length of the body, and the movement up and down is accomplished with the utmost smoothness. No additional labor is necessary over the old method with small end dump cars, the hoist operator controlling the air from his cab. The dumping angle maximum is 45 degrees, allowing a gate opening of 5 ft. 3 in. and swinging clear of stones of the largest dimensions.

New Koppel Quarry Car.

2-Wheel Rear Dump Trailer

A 2-wheel, all steel rear dump hand hoist trailer for use with a Fordson tractor has been brought out recently by the Miami Trailer Co., Troy, O. The frame is 5 in. roller channel iron. The track is 60 in. and the wheels are the artillery type, 3, 4 and 5 in. in size. The height from ground is 48 in. The trailer has a carrying capacity of 2½ tons. This trailer also is furnished in 2 yd. level capacity in water tight body with standard garbage body end.



Miami-Fordson Rear Dump Hand Hoist Unit.

Jaeger Adds to Line of Mixers and Pavers

A larger mixer, known as the 14L, has been brought out by the Jaeger Machine Co., 222 Dublin Ave., Columbus, O. This new model is built along the same lines as the other Jaeger mixers. The machine has been given a thorough tryout, under conditions for which it was designed, to assure complete satisfaction before being offered to the trade. For the past year this model has been through the experimental stage, and has now been adopted as a standardized Jaeger unit. The Jaeger 14L has a capacity of 14 cu. ft. per batch of mixed concrete and will accommodate 21 cu. ft. unmixed materials, using 3 cu. ft. cement, 6 cu. ft. sand and 12 cu. ft. stone. The mixing drum is the standard Jaeger tilting type, for quick loading and discharging. Drum is 52 in. in diameter and 44 in. deep. The new 14L Jaeger mixer has been incorporated into the No. 14P Jaeger paver, adding a larger paver to the Jaeger line. This paver embodies many of the same construction features of the No. 7 size Jaeger paver. The power unit in the No. 14P is a complete Fordson cylinder engine, combined with the differential gears. The concrete is distributed by a specially designed Jaeger boom and bucket. The bucket dumps the batch from the bottom and has a pivot on one side. Thus, the material comes out at once at the control of the operator, who can spread the batch as it is being dumped, so that little additional spreading is required. The machine is sold as a 3-bag paver, using the proportions of 1:2:4, making at least 14 cu. ft. of mixed concrete. It is equipped with big, roomy loader bucket and Jaeger tip-over tank. The traction, ahead or back, is easily controlled by operator.

Bear Tractor

The accompanying illustration from a photograph taken last month shows a Bear Tractor pulling two Baker-Maney scrapers on a dirt moving job in Kansas. The Bear Tractor has a drawbar rating of 25 hp., but there is a 100 per cent overload capacity. Eighty per cent of the engine's power is actually delivered at the drawbar and is available for pulling. The weight is 5,500 lb. net; 6,000 lb. with fuel, oil and water. Over-all dimensions are: Length, 110 in.; width, 60 in.; height 54 in.; turning radius, 6 ft. All oiling is from reservoirs, there being no grease cups anywhere on the tractor. The drawbar is a resilient steel cable attached to the track frame forward of center and below center of gravity, so that it pulls down in front and increases traction. The tractor has a compensating track roller system which equally distributes the weight of the tractor so that the track conforms to the irregularities of the ground, and maintains uniform traction. The extreme ranges of the oscillating bar and the compensating track rollers are stated to give the Bear a maximum of mobility. This tractor is made by Bear Tractors, Inc., 53 Park Pl., New York.

Bear Tractor Pulling Two Scrapers on Kansas Job.

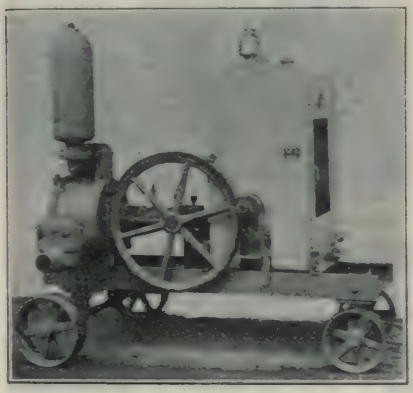
New Balanced Valve for Mixers

A new three-way balanced valve, the culmination of years of study and experimentation, has been perfected by the Koehring Co. of Milwaukee and is now installed as stand equipment on Koehring 21E pavers. In this new valve all of the valve parts which come in contact with water are made of either bronze, brass, rubber or leather, preventing corrosion. It is balanced, automatically operated, permanent, non-freezing, self-draining and completely accessible. Inspection of the valve can be made very easily. Merely remove three bolts and one pin connection and the entire unit can be pulled out of the valve body. The valve can be dropped back into place without any fitting, adjusting or worry. To turn the three bolts down and make the pin connection to operating levers, is only a few minutes' work. A removable housing protects the valve and outside valve parts from stone, sand and cement which may drop from the charging skip. An additional time-saving feature is the automatic opening of the valve to discharge water into the drum. The time of opening the valve is adjustable in the valve operating mechanism. A hand control is also provided for operating the valve. The valve is balanced because the pressures are equal, which allows its easy operation. For two years this type of valve has been installed on Koehring pavers in the field, functioning under the usual severe conditions under which a valve must operate. These valves were then returned to the factory from time to time for inspection and improvement. The valve now announced is the result of these years of expert designing, experimentation and test.

Koehring 3-Way Balanced Valve.

Trench Force Pump

A pump designed to meet the demands for a pump of large capacity to handle the dirty water found in trenches, sewers, manholes, excavations, cofferdams, etc., and discharge it through pipe or hose lines to suitable place for disposal is illustrated. It is also well adapted for small pile jetting and quite extensively used for that purpose. The pump is of the plunger type and is double acting. The packing is held stationary in the pump body thus wiping the plunger clean at every stroke. The valves are in cages having removable tops, which permits easy access for inspection, cleaning or renewals without disturbing either the suction or discharge lines. The engine is a 2-cylinder, 5-8 h.p. providing ample power to discharge capacity of pump through pipe line against a pressure at pump of 50 lb. This power unit is completely housed; the engine has speed control governor, high tension magneto, radiator with cooling fan; and the high speed drive drum gears are enclosed and run in an oil bath. This pump is made by the Domestic Engine & Pump Co., Shippensburg, Penn.



Trench Force Pump.

New Concrete Buster

The illustration shows the new concrete buster which has been developed by the Sullivan Machinery Co., Chicago, Ill., for heavy duty work in breaking pavement, cutting out walls and other concrete breaking work. This is a substantial, strongly made all-steel tool of the non-rotating type, weighing 65 lb. The chuck accommodates 1⅛ in. steel and has an anvil block for transmitting the blow. A heavy spring steel retainer with spiral springs, is used to permit the

Breaking Up Concrete with the "Buster."

drilling tool to be churned up and down without falling out of the chuck. ¾ in. air hose is employed. Two tools are used with this machine; a "bull point" or pick point, and a tool with chisel edge, the former being principally used in breaking up concrete, and the latter for channeling asphalt pavement. From two to three of these tools can be operated by the Sullivan gasoline engine driven portable compressor of 170 cu. ft. capacity. A thumb-trigger throttle permits easy handling. An axial shell type valve is employed, making the tool very compact and economical of air, and imparting a powerful blow to the drill steel.

Statement of the Ownership, Management, Circulation, Etc., Required by the Act of Congress of August 24, 1912,

of EQUIPMENT REVIEW, Quarterly issue of ENGINEERING AND CONTRACTING, published quarterly at Chicago, Ill., for October, 1923.

State of Illinois, County of Cook, ss.

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared E. S. Gillette, who, having been duly sworn according to law, deposes and says that he is the Circulation Manager of the publication Engineering and Contracting, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Engineering and Contracting, 221 East 20th Street, Chicago; editor, H. P. Gillette, 221 East 20th Street, Chicago managing editor, H. P. Gillette, 221 East 20th Street, Chicago; business manager, Louis S. Louer, 221 East 20th Street, Chicago.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.) H. P. Gillette, 221 East 20th Street, Chicago; Louis S. Louer, 221 East 20th Street, Chicago.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

E. S. GILLETTE, Circulation Manager.

Sworn to and subscribed before me this 1st day of October, 1923.

(Seal) KITTIE C. WOULFE, Notary Public.
(My commission expires Feb. 9, 1926.)

Roads and Streets

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.

221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*

LEWIS S. LOUKE, *Vice-President and General Manager*

New York Office: 904 Longacre Bldg., 42d St. and Broadway

RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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(b) Road Maintenance
(c) Streets
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Vol. LX. CHICAGO, ILL., NOVEMBER 7, 1923 No. 5

Bad Roads for Good

If the holders of 25-year bonds of a privately owned and operated property should see that property rapidly approaching destruction through abuse and neglect within five years from the date of the construction, they would very promptly act to protect their investment and their rights. But where a public property suffers the same fate there is generally neither a forceful demand for its protection nor means of enforcing such demand if it were made.

In hundreds of places throughout the country pavements that were laid at a cost that was only justified by an expectation of long life, and which in many cases were built with the proceeds of long term bonds, are going to pieces before our eyes because of lack of maintenance and a character of traffic for which they were not designed. The bond holders do not worry or protest because they are not dependent on the roads for security. The public will have to meet the obligations when they come due. In the interim it is confronted with the financing and construction of new surfaces to replace the old in addition to the betterments and extensions so greatly needed everywhere.

It is obvious that if such conditions obtained for public improvements in general in any particular territory, that territory could not avert ultimate financial disaster. Escape from disaster lies in the fact that the conditions are not general, but this does not save present waste nor justify burdening the future with payments for property which is not handed over to it.

The wants of the future—either immediate or remote—are not likely to be met more easily than are the wants of the present. So far as present signs go, taxes and assessments will keep right on mounting, while as fast as one want is satisfied another

will arise. We refer to the future, not because it is actually more important than the present, but because of a tendency to crowd burdens upon it on the thoughtless assumption that its wants will be only the same as those of today. It is the old story of lack of vision and failure to appreciate that there is nothing final in the present state of our development. Everybody, of course, will deny this but there is a vast amount of action which belies the denial.

The persons responsible for a road which goes to pieces under abuse and neglect are like the owner of an automobile which is depreciating from the same causes. Both road and auto are needed badly, and it is not clear how they are to be replaced; but it is difficult to pay for proper maintenance or to curtail destructive use, and so destruction goes on.

Our roads must be open to all reasonable use, but it is clearly wasteful to design them for loads which only very rarely come upon them, or to allow their destruction by such loads. In some places reasonable load limits are established and enforced. Where they are not, there is sure to be abuse of even the most substantially built road. We know of instances where the road damage of a single truck load greatly exceeded the entire value of the load itself. Speed, as well as maximum load, is a matter for consideration. A five-ton truck traveling at a speed which would be harmless in a light passenger vehicle hammers every irregularity, and the continuation of such hammering leads to destruction in many cases. In some instances the surface might be saved through maintenance—in others it simply cannot survive the usage. Speed is desirable but its limitation according to conditions may be a necessary public economy.

Maintenance of modern road surfaces is not cheap, yet it is far less costly than new construction. Its necessity should require no comment, but the examples of its absence are too numerous and too glaring to pass unnoticed. Every modern pavement which is going to pieces under traffic is a waste which cannot be afforded.

Annual Convention of American Society for Municipal Improvements.—An instructive and interesting program has been prepared for the 29th annual convention of this society, which will be held Nov. 12-16 at Atlanta, Ga. The convention hall and exhibit room will be at the Ansley Hotel. Fred Houser, 404 Chamber of Commerce Bldg., Atlanta, Ga., is secretary of the local committee in charge of the convention, and Joe Glazier, 212 Walton Bldg., Atlanta, is chairman of the committee in charge of exhibits.

Road and Street Contracts Awarded During the Last 44 Months

The accompanying table shows three outstanding facts: First, that highway contracts awarded during the last half of each year have averaged only 25 per cent less in volume than those awarded during the first half; second, that there is not a month in the year without a very large volume of road and street contracts awarded; third, that each year shows a substantial gain over its predecessor.

ROAD AND STREET CONTRACTS EXCEEDING $25,000 IN SIZE

	1920	1921	1922	1923
January	$ 12,204,000	$ 11,598,000	$ 14,424,000	$ 21,691,000
February	21,384,000	12,049,000	9,052,000	18,781,000
March	26,221,000	25,880,000	39,669,000	37,706,000
April	33,340,000	31,026,000	32,991,000	29,641,000
May	30,258,000	35,064,000	42,284,000	46,528,000
June	31,441,000	56,777,000	42,138,000	38,040,000
July	29,353,000	33,943,000	26,087,000	42,397,000
August	18,565,000	28,693,000	37,035,000	35,639,000
September	26,537,000	23,257,000	28,884,000	37,812,000
October	12,894,000	20,055,000	23,162,000	.....
November	12,443,000	20,751,000	20,892,000	.....
December	10,834,000	16,263,000	18,096,000	.....
Total	$265,424,000	$315,356,000	$334,714,000	.....

Note.—About 100 per cent must be added to these totals to give the grand total of highway contracts in the United States.

Bridges are not included, and bridge contracts average 15 per cent as much in value as road and street contracts. A great deal of road and street work is done by directly hired labor and is not included above.

Refined Tar in Road Construction and Maintenance

Recent Developments Outlined in Paper Presented at Hamilton Convention of Good Roads Association

By JOHN S. CRANDELL
Consulting Engineer, The Barrett Co., New York City

As you all know, drainage is the keystone of success in the construction of any type of road. I am not going to enlarge on the importance and necessity of it. You have heard this discussed time and time again. But why do many road builders still put men to work with pick and shovel digging ditches along the roadside when a 2-man road machine will do the work of 20 men? A road machine will not only build your ditches cheaply but will maintain them at a trifling cost. Don't use the expensive pick and shovel when machinery will do the job cheaper and better.

Why are makeshift drains built when good ones cost but little more? Why are head walls left off culverts? Why are culverts so placed that they are sure to fill with silt before the first year has passed? Why, when the road is finished, are the earth shoulders left higher than the pavement so that the water collects at the edges and may not drain away, thus eventually injuring the road? Why are the weeds not cut and the ditches kept clean? Why spend money for drainage systems only to permit them to become worthless through carelessness?

Distributing Stone on Road Bed by Means of an Unloader.

Selection and Use of Roller.—After the soil has been drained and shaped up it is ready for the roller to compact it. The roller is the most important piece of machinery on the job, and the roller man is the most important man, except the boss. The roller should be suited to the job. It will not do to use a 3-ton tandem roller in a location where a 12-ton 3-wheel roller should be used.

I recall one place where a contractor was trying to build 5 miles of tar penetration pavement with a wheezy old 3-ton roller. Had he persisted, it is almost certain that the streets would have been a total failure. It is almost as bad practice to use a

tremendously heavy roller on soft stone. The 10-ton roller is the best all round roller for bituminous macadam.

The roller man, if he is capable and efficient, will know enough to roll the pavement slowly. A speed of 60 ft. a minute is about right, and should not be exceeded. Fast rolling is a great mistake, especially during the first part of the work. The final rolling may be speeded up a little if a medium tandem roller is available, but under no circumstances allow the roller man to exceed a foot a second, at the beginning.

The choice of steam roller or gasoline roller is sometimes dependent on the location. Where water is hard to get and coal is expensive, a gasoline roller is much to be preferred. The saving in time alone is considerable. I saw one job recently where a steam roller had to draw water from a supply two miles away. A trailer equipped with a tank was hitched to the roller and every morning the roller with its trailer journeyed two miles to the stream and two miles back again. It was noon before the roller began to actually work. No wonder road costs are high, and contractors go broke.

Spreading the Stone.—Don't let your roller remain idle. The roller is a mighty handy tractor, and should be used as such whenever it isn't rolling. Instead of spreading stone for the base or the wearing course manually, put the roller to work pulling the road scraper. No matter how badly the stone has been dumped, you can quickly shape it up with these two machines. If the roller is busy, draw the scraper with an auto truck or with horses. It is surprising how quickly and how well the scraper will spread loose stone.

Spreading Stone With Scraper.

Dumping the stone is usually crudely done. There are several types of unloaders that may be purchased, or you can make your own. A convenient form is that illustrated. It is really a bottomless box drawn behind the dump truck which empties directly into the box. As the truck moves forward, it draws the box after it, and the stone is dropped onto the road in a fairly even layer. A little work with the scraper will shape up the loose stone, making it ready for the roller, by using these aids, the cost of spreading stone is reduced materially. There is no longer good reason why men should be employed to do this work with shovels.

Selection of Suitable Stone.—The selection of stone for the road is of much importance. Much money may be saved by using local stone for the base, even if it is not the best quality. On the other hand, money may be wasted by using poor local stone for the wearing course. Sand stone is good enough for the base, while the same stone used in the wearing course would be wholly unsuitable. Sometimes the local stone is satisfactory for both base and wearing course, and when this is true, then there is substantial saving, for freight on stone is high. Occasionally, a good grade of gravel may be found on or near the job, and this makes a good base if carefully compacted. Field stone is good if it runs fairly uniform in size.

The wearing course stone must be of good quality. Limestone, trap, some granite, and hard stones in general, make satisfactory material for the wearing course. Soft or disintegrated stone is worthless. Some slag is good, and some is not. Slag should be selected with care. No brittle, glassy slag should be accepted, nor should soft, chalk like slag be used. A hard air cooled slag, free from flue dust and pieces of metal should be specified.

Application of the Tar.—In applying the refined tar it is cheapest and best to use some form of pressure distributor. The auto truck equipped with a pressure spraying device, is the most convenient, the quickest, and the best.

After the first coat of tar is applied the ¾ in. chips are spread. Here again is an opportunity for saving money by using some form of chip spreader, of which there are several that may be purchased. One form of spreader may be attached to any truck, and spreads evenly and quickly. If piles of chips are deposited along the roadside, it is inevitable that about 5 to 10 per cent are lost through inability of the workmen to pick them up without scooping up soil too. Spreading directly from a motor truck eliminates this waste. After rolling, all surplus chips should be swept off. Then the seal coat of tar is applied and covered with chip stone or pea gravel. The appearance of the road depends largely on the type of cover selected. The cover should be applied mechanically, wherever possible. A final rolling, and the road is ready for traffic.

Spreading Gravel Clinking Course Over Tarvia.

Cost of Tar Macadam.—Now what should a tar macadam cost? For

tunately, there are figures available that are reliable, and we know that in 1922 the cost was about $20,000 a mile on roads in the states where federal aid money was expended. Some of the county work ran higher, and some was lower. A remarkable instance of low cost roads was in Cattaraugus County, New York, where 14 ft. tar penetration roads were built for as little as $14,500 a mile. This figure included everything, drainage, culverts and whatever cut and fill there was. Other roads in the same county ran as high as $20,000 where there was considerable excavation and large culverts or small bridges. The average was $18,000 a mile. Cattaraugus County built 50 miles of tar macadam last year, and will build nearly the same amount in 1923.

Maintenance of Tar Macadam.—Maintenance of the tar macadam is simplicity itself, and is inexpensive. The road is well swept, so as to remove all dirt and filth. Holes and depressions are patched with cold patch tar, or hot tar patches, and then the road is given a surface treatment with a light refined tar, at the rate of about ⅓ gal. to the square yard. This is covered with clean stone chips or pea gravel.

There is one place where the maintenance man may go wrong, and that is in cleaning the road. I have seen more cases of poor surface treating due to this one cause than to any other. It is not sufficient to go over the road once with a mechanical sweeper. It is absolutely necessary that men with shovels and push brooms follows the sweeper and make sure that every particle of dirt is loosened and removed from the surface. Tar will not stick to dirt, to grease, or to wet surfaces. The cover should be selected with care so as to obtain a hard stone or gravel that will take the wear.

Surface Treatment With Tar.—It is becoming the custom to surface treat all types of improved roads. Many miles of concrete roads in New York state were treated last year with refined tar. The treatments are given after the cracks in the concrete have been filled with heavy tar binder. The usual treatment is about ¼ to ⅓ gal. per square yard.

Many miles of gravel have been successfully treated with light tar, and neighboring states are maintaining their country roads at a very slight cost. Some gravels may be treated, and some may not. If you have gravel roads under your jurisdiction, I advise you to get in touch with someone who knows about the subject before you spend any money experimenting.

The surface treating of macadam roads is so well known that I shall not say anything about it here, except to warn you not to use too much tar. Just as in painting a house, it is better to give two light coats of paint instead of one heavy one, so it is in tar surface treatments. Two treatments of tar are better than one heavy coat. Do not endeavor to build up heavy mat coats, for that way lies ripples and bumps. Instead, strive to apply only what has been worn off the preceding season, and thus preserve the surface free from any irregularities.

In conclusion, let me again urge the substitution of mechanical power for man power, with the resultant decrease in costs. Let me warn you to clean your roads before you surface treat them, and to use clean stone and gravel. And let me compliment you on your slogan, "Adequate Maintenance Means Road Economy."

Joint Meeting of Road Engineers and Contractors

A joint meeting of the Associated General Contractors and the American Road Builders' Association will be held in Chicago on Thursday, Jan. 17, 1924, to discuss various matters of importance to the membership of both organizations. This joint meeting has been made possible by the proximity in dates of the annual meetings of these organizations in Chicago. The 1924 convention of the American Road Builders' Association will be held Tuesday, Jan. 15 to Friday, Jan. 18, inclusive, while the Associated General Contractors meet the following Monday, Tuesday and Wednesday. All the officers, the executive committee and the heads of the 28 chapters of the Associated General Contractors will, however, be in Chicago the previous week. Many of the members of the organization also will be in Chicago that week attending the convention and road show of the American Road Builders' Association. Plans accordingly have been made for the joint meeting. Details of the program will be announced shortly.

The Maintenance of Gravel Roads

Suggestions, Based on Experience With Intensive Maintenance on 7-Mile Demonstration Section and on Observations, Given in The Tech Engineering News

By F. D. COPPOCK,
President, The Greenville Gravel Co.

This article is prompted by a sincere desire to help solve in a practical way a vexing problem, irrespective of personal interest. It is intended to convey a practical plan for gravel road maintenance and to impart an idea of costs and results. It is not for the purpose of opposing the construction of the various types. Permanent road construction is necessary, considering the present road traffic. Our object is not to discourage the building of permanent highways, but to encourage economy, and prove that there is a place for gravel in proper maintenance and construction of highways. Proper specifications should be exacted and proper maintenance methods employed in a practical and economical way to the end that we may quickly place our highways in condition to carry the increased burdens of present-day and future motor traffic.

The Demonstration Section.—In order to demonstrate to county officials the results and economies to be attained from intensive maintenance and full-time patrol, we took over, with the consent of the commissioners of Darke County, Ohio, about seven miles of one of the principal highways of the county and have for the past two years maintained the same under what we consider a proper and practical patrol method. Our experience in maintaining this road, together with our careful observation of maintenance on gravel roads in Indiana and Michigan, has placed us in a position to advance suggestions and offer some figures on the costs of such maintenance. We found that we attained results at the end of the first year which we had not hoped to reach before the end of two or three years. In fact, during the thawing season of the first spring the road for its full width was in condition to carry automobile and truck travel without hindrance to the traffic or damage to the road.

A Common Fault in Gravel Road Repair.—The common fault with the old method of road repair is that after the materials have been placed on the road they are left as deposited for the traffic to pack and, as traffic follows only the packed wheel tracks, ruts are created which in wet weather will hold water until it soaks away. This water softens the material on the road and also the sub-grade so that traffic mashes the gravel down, mixing it with the dirt below, causing chuck holes and ruining the road. It is necessary to prevent ruts or depressions which hold water, and this can only be done by dragging often, and by the proper use of the right kind of surface materials.

Most of the old gravel roads have been built from gravel found in local deposits and while they do not as a rule need rebuilding, they do need a different kind of maintenance. Most of these roads have sufficient material on them so that if the proper drainage was provided and proper forming of the road's surface had, very little repair material would be needed to keep them in good condition. The success of gravel road maintenance depends more on the proper drainage and dragging than on the amount of material used.

The common practice of applying gravel in road repair is to dump a full load of gravel in a place, and often one load against another for a considerable distance. This practice is not only wasteful but, considering the present automobile traffic, dangerous as well. It is absurd to place thick layers of gravel on the road and expect it to be packed uniformly by the traffic.

The Importance of Proper Drainage.—The first step—and one of the most important things in the proper maintenance of gravel roads—is drainage. Today the side ditches of our older gravel roads are filled with material washed into them from the fields and from the road's surface, until in most instances there is no ditch or drainage. These ditches should be cleaned out and opened up until there is no

point in them less than 18 in. below the surface of the road. These side ditches should always have outlets to waterways leading from the right-of-way of the road. There should be no pockets or low places in the side ditches which will hold water.

Quite a few of the gravel roads have a sod berm along the edge of the road which is from 2 to 3 in. higher than the road's surface. This has been caused by the use of the scraper. These shoulders are very detrimental and should be done away with, as they prevent the prompt flow of water from the road surface.

Because of the lack of side ditch drainage it has become common practice to ridge the gravel in the center of the road or maintain a very high crown. This was found necessary in order to drain off the water, and form a firm dry portion on which to drive. A high crown is detrimental as it causes all the travel to drive in center of the road, confining the wear to two narrow wheel tracks. The travel should be general over all parts of the road.

Preparation of Road Bed.—After proper drainage has been provided, the surface of the road should be lightly scarified or harrowed and dragged, so as to produce a uniform and smooth surface. This can be done without hindrance to the traffic. The crown or high center of the road can be loosened a little at a time by means of harrowing and this loose material moved with a drag to the low part of the road between the sod berm, or edge of the road, and the center.

This harrowing and dragging should be continued until the center of the road is not more than 3 or 4 in. higher than its edges. After this has been done and proper drainage provided, the road is then ready for surface treatment.

The Kind of Gravel to Use.—Next in importance to drainage and the proper preparation of the road bed, is the character of the material which is placed on the road. Present day traffic requires a different material than formerly. Experience has already taught engineers and those boards and officers having charge of road maintenance that the old methods are inadequate and impractical. The past two years have clearly demonstrated the imperative need of not only adequate drainage and good road beds but of high class material in order to avoid the almost impassable road conditions that we have had during the thawing season of the past few years.

The average bank-run or pit-run gravel, as found in local deposits and commonly used, has proved unfit for use in road maintenance. These deposits do not run uniform in coarseness or quality. Very often they contain too much sand; always too much loam; and at times toom any boulders.

Sand and loam create dust, prevent drainage, and retain moisture. In thawing seasons dirty gravel becomes very soft because of the moisture it retains. The old idea, that repair gravel should be mixed with loam in order to make it pack quickly, is an erroneous one. Repair gravel should have no loam whatever in it. Clean gravel will pack without hindrance to traffic if properly applied and maintained.

Boulders or large stones are very objectionable, as they are inclined to work to the surface, causing an expense to remove and also creating bumps which in turn cause chucks.

Size of Gravel.—In road construction the gravel used should be clean and uniform in its mixture of various sizes from sand to pebbles not larger than 1 and 1½ in. At least 25 per cent but not to exceed 35 per cent of fine sand, 1/10 in. down, should be mixed with the gravel for road construction. A proper sand mixture prevents the sub-soil from coming up through the gravel, which is apt to happen under heavy traffic; at the same time an excess of sand is undesirable. Where a partial rebuilding is needed, or where the road is so nearly worn out that a light surface treatment is not sufficient, a clean gravel should be used, ranging in size from sand to 1 and 1½ in.

For maintaining the average gravel road the material should be that of a very fine clean gravel without sand. A washed and screened pebble ranging in size from 1/10 in. to ¼ in. has proven satisfactory; a pebble from 1/10 to ½ in. is preferred, however. A pebble larger than ¾ in. is never used. These should be applied in very thin layers as required. Each application should be a little more than enough to absorb all the worn-out particles or mud and soil on the surface

of the road. There should at all times be a loose thin coating of this material on the road surface. Dragging the road will remove this loose material, filling in the low places as they occur and keeping the road smooth at all times.

Application of Gravel.—The reason why a fine gravel is better than coarser material for road dressing or surface use is that if larger particles are used the process of dragging will pull the larger stones loose from the surface, making it rough and impossible to keep smooth.

An application of one inch of fine gravel twice during a season will keep a much used gravel road in excellent condition. This requires 400 cu. yds. of material per mile. The average gravel road can be well maintained with one application per season or 200 cu. yds. of material per mile. Roads which are used very little require still less.

The average cost of paved roads, concrete for example, is about $25,000 per mile, the interest at 6 per cent amounts to $1,500 per mile per year. Until the travel becomes heavy, a much used road can be maintained by the proper use of gravel and patroling at a less cost than the interest on the permanent type.

Roads so maintained will give good service during all seasons of the year at a very low cost. Compared with the so-called permanent type, a properly maintained gravel road is as smooth to ride over and as enjoyable, and until the travel becomes moderately heavy, it may be kept in every way as serviceable.

Cost of Proper Maintenance.—As to the cost of proper maintenance. The side ditches of the average gravel road can be cleaned out so as to provide good drainage at a cost of approximately $250 per mile. The other costs depend very materially on the amount of traffic. If the traffic is heavy, the material and labor costs amount to from $600 to $800 per mile per year. If the traffic is medium this cost is $400 per year. Byroads or gravel roads which are used very little can be maintained in good condition at a cost of $100 or less per year.

In order to properly maintain gravel roads, there should be constant employment. A certain number of miles should be placed in charge of one man, employed by the year. He should be provided with a light truck to be used for the distribution of materials, for hauling of refuse, and as a power unit for scarifying, harrowing and dragging the road's surface. The general impression is that dragging should be done when the road is soft or after a rain or thaw. It is as important to drag the road in dry weather as in wet. In fact, a road under ordinary traffic should be dragged at least once if not twice each week, during the entire year. Under extremely heavy traffic it should be dragged each day.

One man can distribute the material, do the dragging, and properly maintain 10 miles of gravel road under heavy traffic, after the drainage has been provided. Where the travel is medium or possibly average, one man can care for at least 20 miles if provided with the proper equipment and materials.

Most Important Features Summarized.—A summary of the most important features in connection with proper road maintenance and the items that should be particularly exacted under governing specifications is as follows:

1. Good drainage.
2. Proper shaping of the road surface with not over a 4-in. crown.
3. Application of clean small pebbles in thin layers.
4. Dragging often, depending on the amount of use.
5. Prompt attention to development of defects.

Neglecting to provide for or perform any of the above mentioned important features in connection with gravel road maintenance will result in failure.

26,500 Miles of Federal Aid Road Completed.—A total of 26,536 miles of federal aid roads was completed by June 30, 1923, according to the United States Department of Agriculture. Some 8,820 miles of federal aid highways of different types were constructed during the fiscal year ending on that date. The projects under construction at the close of the year totaled 14,772 miles and were estimated as 55 per cent complete.

Operation of Municipal Asphalt Plant of Los Angeles

Extract From the Annual Report of Engineering Department of Los Angeles, Cal., John A. Griffin, City Engieer, for Year Ending June 30, 1923

This plant was constructed during March and April, 1915, the original cost being $8,354. It was designed and built by the engineering department, and has been in operation since April, 1915. As originally designed, the plant had four rolls and one 1,000-lb. batch mixer, with an estimated capacity of 2,400 cu. ft. of mixture per 8-hour day. During the period, Feb. 16 to April 6, 1917, the plant was closed for alterations, two additional rolls, one additional 1,000-lb. batch mixer and dust bin, elevator, feed and dust exhauster were built, increasing the daily capacity to 5,000 cu. ft., or 250 tons, of mixture per 8-hour day.

During the fall of 1916, a concrete two-compartment storage and heating tank was built, with a capacity of 390 bbl. of asphalt. During 1921, an additional tank was constructed, and a small crushed installed for crushing gravel screened from the sand. From March 10 to April 23, the plant was closed for alterations and betterments. Two 2,000-lb. batch mixers with the necessary appurtenances were installed, replacing the two 1,000-lb. mixers. The original cost of the present plant, that is, the plant as at present constituted, after crediting plant account with the original cost of such units as have been replaced or abandoned, is $43,000, of which $11,000 have been charged to

Table I

Year	Days Operated	Av. Output Per Day Cu. Ft.	Std. Surface Mixt. Cu. Ft. Produced	Std. Surface Mixt. Cost Per Cu. Ft. Cts.	Rock Surface Mixt. Cu. Ft. Produced	Rock Surface Mixt. Cost Per Cu. Ft. Cts.
1914-15	56	1,234	58,330	14.32	.....	.....
1915-16	278	1,255	335,340	13.62	.....	.....
1916-17	239	1,474	309,860	13.40	.....	.....
1917-18	271	2,333	548,100	15.94	.....	.....
1818-19	267	1,579	223,110	18.59	.....	.....
1919-20	270	1,636	210,570	19.65	.....	.....
1920-21	279	2,118	60,350	17.64	378,190	18.53
1921-22	270	2,284	.....	.....	446,940	17.72
1922-23	244	3,715	.....	.....	329,710	15.14
Total and average	2174	2,015	1,745,660	15.84	1,154,840	17.42

Year	Topeka Mixt. Cu. Ft. Produced	Topeka Mixt. Cost Per Cu. Ft. Ct.	Bithulithic Mixt. Cu. Ft. Produced	Bithulithic Mixt. Cost Per Cu. Ft. Ct.	Warrenite Mixt. Cu. Ft. Produced	Warrenite Mixt. Cost Per Cu. Ft. Ct.	Binder Mixt. Cu. Ft. Produced	Binder Mixt. Cost Per Cu. Ft. Ct.
1914-15	.....	.....	.....	.....	.....	.....	8,800	9.29
1915-16	.....	.....	2,540	11.39	.....	.....	10,940	11.12
1916-17	.....	.....	14,310	11.75	.....	.....	14,960	11.18
1917-18	700	15.99	23,430	14.60	36,230	16.79	23,720	13.76
1918-19	87,080	16.45	550	18.53	92,880	17.38	14,950	15.23
1919-20	166,320	17.85	.....	.....	40,460	17.92	23,140	15.71
1920-21	56,010	17.97	.....	.....	.....	.....	33,690	17.98
1921-22	24,320	17.06	4,810	17.88	1,900	17.22	15,850	16.37
1922-23	156,640	13.99	600	15.81	2,330	16.49	.....	.....
Total and aver.	491,070	16.52	46,240	13.85	173,800	17.37	146,050	137.4

Year	Asph Concrete or Rock Mixt. Cu. Ft. Produced	Asph Concrete or Rock Mixt. Cost Per Cu. Ft. Ct.	Special Mixt. Cu. Ft. Produced	Special Mixt. Cost Per Cu. Ft. Ct.	An. Total Cu. Ft. Produced	Av. Cost Cost Per Cu. Ft. Ct.
1814-15	.....	.....	1,980*	32.54	69,110	14.19
1915-16	.....	.....	.....	.....	348,820	13.53
1916-17	.....	.....	13,270†	11.01	352,400	13.15
1917-18	.....	.....	.....	.....	632,180	15.86
1918-19	3,050	13.89	.....	.....	421,620	17.73
1919-20	.....	.....	1,260	16.33	441,750	18.60
1920-21	62,480	18.99	.....	.....	590,720	18.40
1921-22	122,970	15.89	.....	.....	616,790	17.28
1922-23	416,890	14.16	.....	.....	906,170	14.49
Total and average	605,390	15.23	16,510	14.00	4,379,560	16.25

*Non-skid mixture. This mixture was treated with certain chemicals to reduce the tendency of automobiles to skid.

†Special binder mixture.

Table II

	Std. Surf	Rock Surf	Topeka	Bitul.	War.	Binder	Asph. Con.
Asphaltic cement	100	150	120	60	60	55	110
Stone dust	100	200	180	75	75	50	100
Sand	800	1,500	1,140	290	265	345	600
Crushed rock, ¼ in.	.....	150	560	.....	100	100	440
Crushed rock, ½ in.	.....	.....	.....	575	200	250	.....
Crushed rock, ¾ in.	.....	.....	.....	.....	.....	.....	550
Crushed rock, 1 in.	.....	.....	.....	.....	300	200	100
Single batch, pounds	1,000	2,000	2,000	1,000	1,000	1,000	2,000

operating expenses, as depreciation of plant, giving a present value of $32,000. The plant with the two 2,000-lb. batch mixers, has a present estimated maximum capacity of 8,000 cu. ft., or 400 tons per 8-hour day. Changing from a 1,000-lb. batch mixer to 2,000-lb. mixers, when operating at full capacity, will reduce the cost of the product 6 per cent or about eight-tenths of 1 per cent per cubic foot. Therefore this alteration in the design of the plant will save its cost in less than one year, due to the reduced cost, only, of the present product. In addition to this, large savings will be made, due to the reduced time necessary to load the trucks and the elimination of gang delays, or slow downs which waiting for material.

The result obtained from the operation of this plant should be gratifying to the municipal officials as well as the taxpayer. Before a municipal asphalt mixing plant was conceived, the city paid $.19 per cubic foot, (100 lb.), for surface mixture. From this was deducted about 1 ct. per cubic foot as provided in the specifications then in use, making a net cost of approximately 18 ct. per cubic foot. Immediately prior to the construction of this plant, the city paid from $.20 to $.25 per cubic foot for wearing surface mixture. In 1920, it paid $.50 per cubic foot for a small amount of Warrenite mixture. During March and April, of the present year, while the plant was closed for alterations, it paid $4.20 per ton ($.21 per cubic foot, or per 100 lb.) for surface mixture, and $4.00 per ton ($.20 per cubic foot, or per 100 lb.) for rock mixture. From a study of the foregoing and a knowledge of the trend of material costs, since April, 1914, it is evident that the average market price for all classes of mixture has been considerable more than $.21 per cubic foot, but figured on a basis of a market value of $.21 per cubic foot, the plant has made a profit of $2,000 per month or in excess of $20,000 since April, 1914.

Table I shows the output and cost per cubic foot for the different classes of mixture produced during each year of the life of the plant.

Care should be taken not to compare the average cost for the nine years of one class of mixture with that of another class, as such comparison would lead to an erroneous conclusion as to the relative cost of the several mixtures. For such use comparisons should be made of data for a single year only.

Table II gives the proportions used in the various mixtures indicated in Table I. These proportions are changed from time to time so that these herein given are those being used of this date, or, for mixtures not now used are the proportions used for the last of such mixture produced.

Paving Brick Orders Increase

An increase in unfilled orders for vitrified paving brick from 88,247,000 the last day of August to 91,048,000 the last day of September is announced by the National Paving Brick Manufacturers' Association of Cleveland in its monthly statistical report to the United States Department of Commerce. This increase was accompanied by a similar upward movement of stock on hand. Many of the orders are for delivery next spring and in the early summer. Production for the month of September increased from 33,457,000, the August total, to 34,457,000. Shipments declined from 36,446,000 to 34,761,000. Distribution for the month found Ohio in the lead with 9,112,000 evenly divided as to city streets and country highways. Illinois, Kansas, Nebraska and Pennsylvania were next in line. Of the unfilled orders 52,216,000 are to go for city streets and 26,535,000 for country highways, the remainder going into miscellaneous markets.

"Invisible Track" Type of Highway

Experimental Section Being Constructed in Kentucky

The State Highway Commission of Kentucky is constructing an experimental section of a new type of highway designed by S. B. Morse. We are indebted to the Kentucky Road Builder, the official publication of the Commission, for the following details.

The sketch showing a section of single track road 16 ft. wide illustrates very clearly the idea, which is simply that two reinforced concrete beams are constructed at approximately 5 ft. from center to center, and 18 in. wide. These are then covered with 1½ in. of rock asphalt or any bituminous material used for road surfacing. To assist traffic in following the trackways a rise of 3 in. is made between tracks, or just enough to indicate where they are, and to make it easier driving along them, than with two wheels on the elevated section.

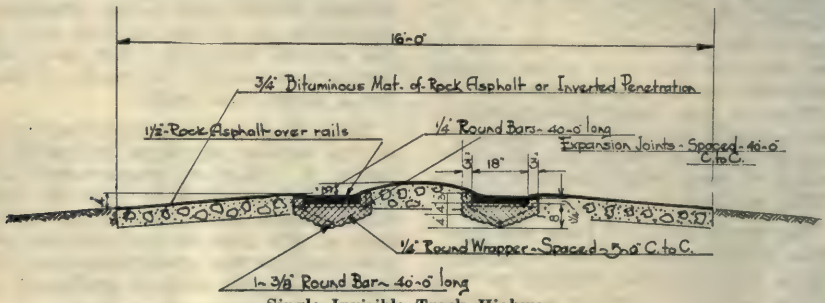
The four concrete trackways show broken stone between them, which will merely support the lighter vehicles as they pass slower and more heavily loaded trucks, while the substantial concrete beams support the heavily loaded vehicles and also the lighter ones except when they are passing.

The road is not really a trackway, but rather a surface deformed in such a way that traffic will concentrate within narrow limits on the surface, and those narrow limits are designed in conformity with the principles of sound mechanics to carry the wheel loads that pass over them. The surface over the rails is made renewable, thus insuring a low maintenance cost.

The basis of the design is that the psychology of traffic demands a rut and this road is built to conform to the demand rather than to oppose it.

Experiment at Pineville.—The section under construction by the Kentucky Highway Commission is located at Pineville, Ky. It is 18 ft. in length. Several different mixes of concrete are being used, as well as both limestone and sandstone aggregates, the idea being to determine the relative values of the mixes and aggregates under actual traffic.

The concrete trackways are to be covered with 1½ in. of native rock asphalt. The spaces between the trackways and on either side of them will be covered with what is known as inverted macadam penetration.



Single Invisible Track Highway.

This is very similar to ordinary surface treatment as applied to macadam roads in Kentucky, and simply means that about ½ to ¾-in. bituminous macadam covering will be provided.

All the details of design for this experiment have been worked out by Mr. Moore, who is superintending the construction. It is believed that some improvements have been made over previous designs used in Louisiana and Texas.

Estimated Cost of Constructing.—This type of roadway, according to the Kentucky Road Builder, is particularly well adapted to use along old macadam roads that have worn down to the point where a new surface must be provided. With specially designed machinery it will be possible to excavate trenches in the old macadam, in which to construct the concrete beams.

Where double track is needed, it will usually be necessary in Kentucky to widen the old macadam roads from 4 to 6 ft., as most of them are only

12 to 14 ft. wide at present; it will also be necessary to provide for additional crushed stone between the trackways in places where slight revisions are made in the old grades. With these points in mind it has been estimated that the cost of constructing 1 mile of double track road, 16 ft. wide will be as follows:

Concrete in beams	$4,250
Reinforcing steel	500
Trenching and dressing up old grades	600
Rock asphalt 1½-in. thick in trackways	1,760
Inverted penetration	1,900

This makes a total of $9,010 per mile. For the cost of additional stone along edges and between beams as mentioned already $2,000 has been added, bringing the total for one mile of road to $11,000.

It must be borne in mind that this estimate does not include any earth excavation for revision of alignment or grading, nor does it include any drainage structures. It is based upon the idea of using machinery for both trenching and mixing concrete.

Experience of Other States.—Two years ago a piece of invisible track road was built in Louisiana along a road that is subjected to very heavy traffic, such as trucks loaded with bales of cotton. This, according to good authority, has stood up so well that the engineer in charge proposes to build more of the same type.

Another short section was constructed in Texas about a year ago. This also, is believed to be giving good service.

Kentucky was the third state to build a section of road after the new design. This was undertaken because it offered a possible solution to the problem of building a road that will endure heavy traffic at a lower price. The road is patented, but an agreement has been made for the Pineville experiment at a nominal sum.

Truck Load Restrictions for Rhode Island and Connecticut Highways

Restrictions of the weight of trucks carrying loads over a number of Connecticut highways is likely to follow a survey now being made of freight and traffic conditions. Although no definite program has yet been decided upon, the limitation is being considered in view of the heavy truck traffic that now traverses the state.

In answer to an inquiry from the Rhode Island board of public roads, Highway Commissioner John A. Macdonald has replied that at present, at least, there will probably be no restrictions of loads under the state's 25,000 lb. limit on roads leading into Rhode Island. This maximum weight limit is fixed by statute. The highway department, however, has authority to make further restrictions if the safety of the public highways is endangered by over-loading of trucks.

As a result of a statute recently enacted in Rhode Island, the maximum weight of trucks carrying loads over roads in that state will be 20,000 lb. In a good many cases, however, it has been found necessary to restrict loads to as low as 10,000 lb. on roads deemed unable to withstand a continued heavy traffic. Restrictions contemplated in that state are now being prepared for the spring of 1924, when the seasonal thaws work havoc with the highway surfaces and foundations alike.

Of particular interest to Connecticut truck owners is the schedule of restrictions proposed by Rhode Island state officials with regard to roads crossing the Connecticut-Rhode Island state line. In some instances it has been found necessary to place a 15,000 lb. limit on roads leading from Rhode Island into Connecticut.

Federal Aid Road Construction

Federal aid roads totalling 8,820 miles were completed during the fiscal year ending June 30, 1923, bringing the total of federal aid roads completed to 26,536 miles. The mileage completed during the year is classified as follows:

	Miles
Graded and drained	1860.1
Sand-clay	749.5
Gravel	3815.4
Waterbound macadam	335.6
Bituminous macadam	452.9
Bituminous concrete	76.8
Concrete	1440.3
Brick	78.8
Bridges	10.8
	8820.2

The projects under construction at the close of the fiscal year amounted to 14,772 miles and were estimated as 55 per cent complete. In addition to the 26,536 miles completed and the 14,772 miles under construction there were at the close of the year a number of projects approved but not yet placed under construction, the aggregate length of which was 6,917 miles.

Asphaltic Concrete Construction in Fresno County, California

Materials, Methods and Results Described in Paper Presented Aug. 29 at Asphalt Convention at Denver, Colo.

By CHRIS P. JENSEN
County Surveyor, Fresno County, California

In Fresno County 152 miles of county highway 16 ft. wide have been constructed in which the entire structure is of asphaltic concrete 5 in. thick. Recently contracts were also awarded for the construction of 7 miles of 5 in. and 11 miles of 4 in. asphaltic concrete highways. More are to follow. In 1909 the city of Fresno commenced extensive asphaltic concrete pavement construction and since then with little interruption, this type of pavement has been the accepted standard. The maintenance on all these pavements has been negligible.

Base Course.—I quote as follows from the Fresno County specifications controlling the manufacture and laying of the case course:

(a) Composition: The base course shall be composed of crushed stone, gravel or crushed gravel, sand, stone dust or lime dust, and asphaltic cement, in the following proportions by weight:

Passing a screen having 2½ in. round openings and retained on a screen having 1½ in. round openings	35% to 45%
Passing a screen having 1½ in. round openings and retained on a screen having ¾ in. round openings	15% to 25%
Passing a screen having ¾ in. round openings and retained on a screen having 10 meshes to the inch	10% to 20%
Passing a screen having 10 meshes to the inch	20% to 30%
Asphaltic cement	4% to 9%

Materials passing the 10-mesh screen shall conform to the following proportions by weight:

Sand, passing a 200-mesh screen	5% to 10%
Sand, passing an 80-mesh screen, and retained on a 200-mesh screen	20% to 35%
Sand, passing a 40-mesh screen, and retained on a 10-mesh screen	3% to 45%
Sand, passing a 10-mesh screen, and retained on a 40-mesh screen	20% to 30%

For the purpose of these specifications, 1,000 lb. of asphalt concrete composition for base course shall be considered as sufficient to cover 24 sq. ft. of roadway.

"**Mixing and Laying.**—The plant wherein tne materials are mixed shall be provided with at least four separate bin compartments for the storage of mineral aggregates.

All the mineral aggregate entering into the mixture shall be accurately weighed by means of multiple beam scales. Asphaltic cement shall be controlled and weighed separately from the mineral aggregate.

All mineral aggregate shall be uniformly heated in suitable driers to a temperature of between 300 and 400° F. previous to being conveyed to mixer.

The asphaltic cement shall be heated to such a temperature that, when discharged into the mixer, it shall have a temperature of not less than 200° nor more than 300° F. At no time shall asphaltic cement be heated to a greater temperature than 325° F."

On account of the close relationship existing between the base course and the wearing surface, and the resulting homogeneous character of the combined structure, I quote as follows from the same specifications pertaining to the wearing surface:

"**Binder Course.**—The binder course, after thorough compression, as hereinafter specified, shall be at least 1¼ in. thick, and shall be composed of crushed stone, gravel or crushed gravel, sand, stone dust or lime dust, and asphaltic cement in the following proportions by weight:

Passing a screen having 1 in. round openings and retained on a screen having ½ in. round openings	30% to 50%
Passing a screen having ½ in. round openings and retained on a screen having ¼ in. square openings	15% to 25%
Passing a screen having ¼ in. square openings and retained on a screen having 10 meshes to the linear inch	6% to 17%
Passing a screen having 10 meshes to the linear inch	22% to 35%
Asphaltic cement	5% to 7½%

Materials passing a 10-mesh screen shall conform to the following proportions by weight:

Passing a 200-mesh screen	10% to 18%
Passing a 80-mesh screen	30% to 45%
Passing a 40-mesh screen	60% to 80%

For the purpose of those specifications, 1,000 lb. of mineral aggregate shall be considered as sufficient to cover 66 sq. ft. of base surface."

"**Finishing Course.**—The finishing course, after thorough compression, as hereinafter specified, shall be at least ¼ in. in thickness and shall be composed of sand and asphaltic cement in the following proportions by weight:

Sand, passing a 200-mesh screen	10% to 20%
Sand, passing a 80-mesh screen, and retained on a 200-mesh screen	20% to 30%
Sand, passing a 40-mesh screen and retained on an 80-mesh screen	30% to 40%
Sand, passing a 10-mesh screen and retained on a 40-mesh screen	20% to 30%
Asphaltic cement	10% to 14%

For the purpose of these specifications, 1,000 lb. of finishing course mixture shall be considered as sufficient to cover 400 sq. ft. of surface."

The base course in the above specifications contemplates a 3½ in. thickness, and the wearing surface specifications contemplates a thickness of 1½ in., making a total thickness of the combined structure of 5 in.

I desire to direct particular attention to those clauses in the specifications requiring 1,000 lb. of mixture to cover only a specified maximum area of surface. We have found this specification to work out most successfully, and incidentally it removes one of the greatest points of contention between the contractor and owner. This ratio of weight to area is based upon a mineral aggregate having a specific gravity of 2:80; if a mineral aggregate having a less specific gravity than 2.80 is used, it will result in a slightly thicker pavement, but at no extra expense to the contractor, for the reason that mineral aggregate in California is commercialized on a tonnage basis.

Proportions of Mineral Aggregate.—The actual proportions of mineral aggregate used in Fresno County work and being in conformity with the requirements of the specifications will generally run about as follows:

From bin No. 4 (large rock)	450 lb.
From bin No. 3	200 lb.
From bin No. 2	100 lb.
From bin No. 1 (fines)	250 lb.

To which is added 45 lb. of asphalt of approximately 45 degrees penetration, standard No. 2 needle; the ductility of the asphalt is never less than 100 centimeters by the standard ductility test.

The fact that in Fresno County asphalt of 45 degrees penetration is specified does not necessarily point to the use of this consistency throughout the United States, or even the west. The proper penetration to be used in any particular community should be the expression of the engineer's best judgment, after carefully considering climatic conditions.

The 200 Mesh Material.—It has been common practice in the manufacture of asphaltic concrete to use hydraulic cement, or lime dust, or the by-product of sugar beets, to supply the necessary quantity of 200 mesh material, oftentimes lacking in fine aggregates. We wish to emphasize our experience that this practice results in a much inferior pavement than if these adulterations are eliminated; we therefore insist upon the importation of a sufficient quantity of 200 mesh sand to bring the mineral aggregates to the proper proportions. I might mention here that in one case a local sand material was found in which the 200 mesh material predominated, resulting in the contractor having to install a blower to eliminate the surplus dust as the materials went through the heating rollers.

Paving Plants.—The paving plants operating in the west are usually of three sizes: of 1,000 lb., 1,500 lb. and 2,000 lb. capacity each.

The devices for heating the mineral aggregate may be of the even drying type, or by direct flame applied as the mineral passes through rotary steel cylinders.

Considering expert knowledge is required for the proper mixing and laying of an asphaltic concrete pavement, and the lack of experienced labor, and inspection, will in nearly every case prove disastrous. A sieve analysis of the aggregates should be made at least every hour at the plant, so that any material variations in the uniformity of the aggregate may be instantly detected and corrected. It is necessary that the asphalt be stored in waterproof containers, because the infiltration of even the smallest amount of moisture will cause the asphalt to form. Great care must be exercised by the mixer operator in weighing the proportions of aggregate from each bin; it is very easy to permit a few extra pounds of aggregate from any one bin to enter the

mixing mill by the careless manipulation of the scales and gates.

In warm weather we prefer to keep the temperature of the mixture from 250 to 260° F.; in cool weather we generally employ a temperature of about 280° F., subject to variations made necessary by conditions of distance hauled.

Spreading and Rolling.—In spreading the mixture on the grade, we insist that the truck drivers become so experienced that the material can be spread upon the previously measured area so uniformly as to render it necessary to make but little adjustment with shovels; we find this method to be superior and more efficient than the use of mechanical spreaders.

Rolling is a very important step in the construction of a proper asphaltic concrete pavement, and particular attention is given to this deail. Two 12-ton 3-wheel rollers are always on the job, and rolling is continued until no further compression is possible, and until the mixture has assumed its proper specific gravity, and will show no further marks by the rollers. Transverse rolling is always employed on city streets, but in the case of comparatively narrow highways, transverse rolling cannot always be accomplished; diligent diagonal rolling is, however, required.

Inspection service is strenuous, both at the plant and on the street. Every operation is under constant control, and the resultant mixture very carefully watched. The plant inspector indicates the weight of every truck load of material on a card, which is taken by the truck driver to the inspector on the street, who then marks off the proper area upon which the material should be spread. Adjustments are made where necessary owing to inequalities in the subgrade.

Raking, as you all know, is also an important factor in producing good results, and it is useless for any inexperienced men to attempt this work.

As an aid to maximum plant output, we find it advisable to have provided a compartment under the mixer to receive the contents of a mixer batch. By this expedient the mixing of materials will not be delayed by reason of a short delay on the part of trucks.

In ordinary weather a load of mixed materials will retain its temperature remarkably well. We have frequently hauled this material 20 to 30 miles with a loss of only 4 or 5 degrees in temperature.

Traffic on Base Course.—We do not hesitate to permit traffic on the base course, after it has cooled. In fact we frequently lay a stretch of base 5 miles or more in length and permit the contractor to haul the wearing course mixture over it, up to a total gross truck load of 12 tons. We encourage the distribution of this traffic over the entire width of base, so that any serious defects in the subgrade will develop before the application of the wearing course, and any unevenness be corrected and absorbed by it. We find under such procedure, that after a few weeks of traffic over the complete pavement that the whole structure has become blended into one compact and integral mass.

In mixing the materials in the plant, we prefer that coarse aggregate be placed in mixing mill first and then fines and asphalt added gradually, so as to produce a complete and effective covering of every particle of stone with asphaltic cement.

Mineral Aggregates.—Fresno County has employed coarse mineral aggregates of both rounded gravel surfaces and of crushed quarried stone in which, of course, all surfaces are angular. The results of our experience are interesting. Contrary to the usually accepted theories, we obtained the better results with the use of round surfaces. We find that the crushed rock will bridge, one particle of stone against another. This bridging action is so effective that, unless crushed under the roller, it will prevent a thorough compaction. On the other hand, gravel aggregate having rounded surfaces will permit of sufficient displacement, internal movement or adjustment, under the action of the roller, so that a much greater degree of compaction will result than in the case of quarried stone.

The ultimate result in the case of a gravel aggregate is a smooth riding surface, and in the case of quarried rock, the fine aggregate tends to settle into the larger interstices of the coarse aggregate, after a period of two or three months traffic, and results in a slightly corrugated riding surface.

In the west, where asphaltic concrete base is used, 85 per cent of the pavements are of a total thickness of 5 in. or less, including the wearing surface.

Proportioning Concrete Mixes

Report Presented at International Road Congress, Seville, Spain

By R. W. CRUM,
Engineer of Tests, Iowa State Highway Commission

Recent researches showing the effect of amount of cement, grading of aggregates, and water content upon the quality of concrete have called attention to the need of more exact methods of proportioning concrete mixes, and a decided tendency toward scientific methods of proportioning is apparent.

Current Practice.—Three types of specifications are in current use.

(a) Arbitrary statements of proportions by volume with specific requirements as to amount of cement per unit of volume. The most used mixtures are 1:1½:3, 1:2:3, 1:3:3½, and 1:3:4. In this case it is customary to vary the proportions in the field by cut and dry methods. This is a fertile source of controversies and lacks accuracy, since other factors effect the result.

(b) Arbitrary statement of proportions by volume with provision for varying ratio of sand to coarse aggregate to secure maximum density. It is the intent in this case to vary the ratio of sand to coarse aggregate to secure the densest aggregate possible with the materials at hand. The ratio of cement to total aggregate being definitely established. The most used mixtures are 1:4½, 1:5, and 1:6.

Methods for Combining Aggregates.—Three methods for combining aggregates are in use.

Fuller's Curve of Maximum Density. Wm. B. Fuller formulated a rule for establishing grading of aggregates for maximum density. In concrete paving practice the mixture of sand and coarse aggregate would be made to approximate Fuller's "Ideal Grading," as close as possible. Reference: "Concrete Plain and Reinforced," by Taylor and Thompson.

Fineness Modulus. Professor D. A. Abrams, of Lewis Institute, has proposed the use of the "Fineness Modulus." In practice the procedure would be to arrange the aggregates so that this function would be as near as possible to the value indicated by research as most suitable for the quality of concrete desired. The "Fineness Modulus" is a numerical function of the sieve analysis of the aggregate. Reference: Bulletin No. 1, Structural Materials Research Laboratory, Lewis Institute.

Surface Area. This method devised by L. N. Edwards, is based upon the assumption that the total surface area of the particles is a measure of the quality of the aggregate. Reference: Proceedings American Society for Testing Materials, 1918-1919. In as much as the actual total surface area is difficult to measure, Professor A. N. Talbott has suggested the use of a "Surface Area Modulus" which is a direct function of the surface area and readily derivable from a sieve analysis.

Inasmuch as all three of the above methods depend upon detailed sieve analyses, they are not directly applicable to hour to hour control of mixture, but when used, are for the purpose of establishing proportions upon sources of supply. Under such specifications, very often no attempt is made to vary the mixture, since the field engineer is rarely equipped to analyze the materials.

Proportions on Weight Basis.—In Iowa the proportions are stated on a weight basis, and provision is made for the use of mixtures with different ratios of sand to coarse aggregate. This method is based upon the assumption that the ratio of sand to coarse aggregate by weight is a determining factor as to the amount of cement. This specification also provides for the use of natural unscreened gravel in special cases. Measurements may be made by volume if frequent determinations of unit weight are made. If unscreened gravel is used, frequent analyses must be made in order to adjust the proportions for variations in the sand content. Reference: Bulletin 60, Engineering Experiment Station, Iowa State College, by R. W. Crum.

Water Content. Improved methods of proportioning are of no avail unless provision is made for the control of water content. Description of the consistency desired, slump or flow table test limits, or specified water cement ratio are the methods used for

control of consistency. Probably the slump test is the most widely used.

Proposed proportioning methods include, Fuller's curve, Fineness Modulus, Surface Area, and the Iowa sand-coarse aggregate ratio method, as mentioned above, and also Professor A. N. Talbott's method based upon the use of the mortar-void characteristics of sands. Reference: A. S. T. M. proceedings, 1921. Inasmuch as American contracting practice requires that the proportions be stated in advance of the letting of the contract, and since little chance is given for the application of detailed methods to the variations in the hourly run of the materials, it is probable that the next step in the development of American practice in proportioning materials for concrete roads will lie in the application (as by the Iowa Highway Commission) of the scientific methods now available to the establishment of proportions for the materials available over districts where similar conditions prevail, and in more exact control in the field of measuring operation.

Storage Tanks for Asphalt and Road Oil

Report Presented at International Road Cngress, Seville, Spain

By W. H. KERSHAW,

Manager, Asphalt Sales Department, Texas Company, New York

To insure prompt release of equipment and the maximum use of its trackage, American railroads have adopted the practice of allowing 48 hours free unloading time for tank-cars and make a charge of $2.00 per day for the first four days after the expiration of the free time and $5.00 per day for every day thereafter.

The tank-cars do not belong to the railroad, but are the private equipment of the producers of asphalt and road oil.

For the same reason given above for "railroad demurrage" charge and the additional purpose of providing for interest and depreciation on their investment, the asphalt producers render an additional charge for "car service," varying from $1.50 to $3.00 per day.

The delay in releasing tank-cars where the material moves direct from the tank-cars to the road oil distributor or to the tanks of the asphalt mixing machine, results in the payment by the purchaser of a considerable sum for "demurrage" and "car service." This payment is a direct loss. A real saving in money can be made by erecting storage tanks at receiving points, and in addition to the saving, secure freedom from interruption due to delayed receipt of material from the producer, and the additional assurance that the business will be attractive to the producer, who is thus insured against delay in the handling of his cars.

For the above reason, practically 40 per cent of all maintenance plants of the United States have installed asphalt storage tanks.

Many cities and counties have installed road oil storage and the practice of establishing asphalt storage tanks has become general with asphalt paving contractors.

The majority of storage tanks installed to date are of steel and elevated, thus giving the advantage of gravity feed to the kettles and distributing wagons.

The use of concrete underground storage tanks is very limited and confined in the main to manufacturing plants.

The yardage of improved pavements in municipalities and counties is so large as to make it advisable to install municipal or county owned maintenance plants. These plants combine with their asphalt and road oil storage equipment, facilities for the handling and storage of mineral aggregate, construction materials, steam plant for furnishing steam for unloading tank-cars, maintaining heat on the storage tanks and for the operation of asphalt mixing plants. At these maintenance plants, the bituminous mixture is prepared and sent out.

Three of the most modern installations of this type are those of Bergen County, N. J., Tarrant County, Tex., and the city of Worcester, Mass. In the Bergen County plant, the large storage tanks with a small heating area for the bulk storage are supplemented by smaller storage tanks with large heating area to prepare the material for immediate use, either through distributors, or for the mixing plant.

Building a Highway Through Four Miles of Swamp

Methods of Constructing Embankment, Trestles and Bridge Through Santee River Swamp Described in The Military Engineer

By LELAND F. JAMES

Federal Aid Project No. 85 includes the construction of a bridge with trestle connections across the Santee River and swamp near St. Stephen, 40 miles from the sea coast, an undertaking which may be regarded as one of the largest and most important of its kind in the South, if not in the entire country. It covers a length of nearly 4 miles through an all but impenetrable swamp, and when completed will form the main link in the proposed Atlantic Coastal Highway.

Embankment Construction Through Santee River Swamp.

Project of Far-reaching Importance.—The importance of this major project lies not only in supplying the missing link for a prominent highway, primarily designed as the shortest practicable route between points along the eastern seaboard, but also in providing the means for developing better highway transportation facilities, and in opening up to the world those fertile sections which have been isolated, in large measure, between the dense river swamp on one side and the broad Atlantic ocean on the other.

The first steps toward laying the foundation for this much needed improvement were made about two years ago when those three counties—Charleston, Williamsburg and Berkeley—most interested in centrally locating the connection, voted a bonded indebtedness to defray one-half the cost of construction, and organized into what is now designated as the Santee Bridge District. Following this action, the South Carolina State Highway Department secured a government allotment for the remaining half of the cost.

Mr. J. L. Parker, Special Bridge Engineer, was placed in charge of all details leading up to the actual construction, including the complete design of the structures and their exact location, and he has since had general supervision of the work for the State Highway Department.

The present site of the bridge was selected from the most desirable of four lines run through the swamp conveniently near that point which would conform to the route of the proposed highway. Great difficulties were encountered by the survey party engaged in this work, in cutting through a flooded swamp overgrown with large trees and heavy underbrush.

The project as a whole embraces about every feature that could be included in swamp-road and bridge engineering consistent with economy of construction; and the several firms to whom the contracts were awarded, in the spring of 1921, have brought into use a great amount of valuable building equipment suited to the nature and magnitude of the undertaking.

The Swamp Trestle Work.—Leaving aside the main channel bridge spanning a substructure of five concrete piers, the one outstanding feature is the swamp trestle work, which consists of seven reinforced concrete bridges, so apportioned in lengths of 782, 733, 1,320, 1,272, 588, 588 and 806 ft., respectively—or a total length of 6,089 ft.—and so located with proper reference to a predetermined rate of water flow at various points

as to secure an adequate discharge of the highest swamp flood waters.

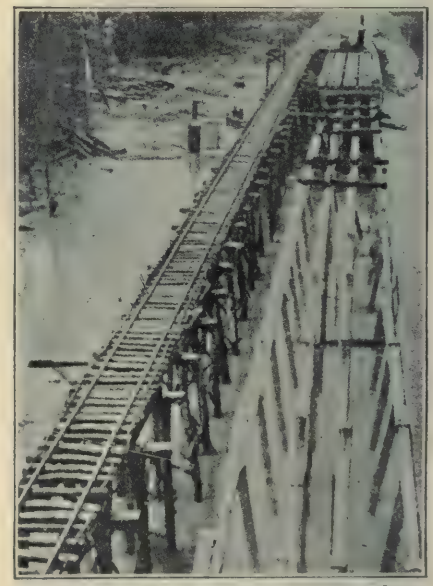
Each concrete bridge deck is poured in place along with stringer plates on caps supported by reinforced concrete piles driven in 4-pile bents, 24 ft. between bents, and carries an 18-ft. roadway.

The concrete piles are about 45 ft. long and 16x16 in. reduced to 8x8 in. at the lower or driven end. They are cast in steel forms laid down in a suitable pile yard, conveniently located. Pourings of the proper mixture are made into the form and left to set for 7 days. The finished pile is then taken out of the form and stored for 30 days, after which it is ready to be driven into place.

After driving the two center piles vertically in each bent, the two outer piles are driven at an angle to brace the structure more effectively. Alignment is secured lengthwise by sighting along accurately located wood patterns; crosswise, by driving against a 3x12 in. timber placed horizontally across the face of the first pile driven in each bent. The accurate alignment thus obtained is attested by the fact that, after the bents are finally braced into position, errors, as far as can be detected with the eye, are about as negligible as if the entire foundation had been driven as a solidly assembled unit. Obviously, these permanent concrete structures over so great a length will materially lessen the future cost of maintenance.

Earth Fills Reduce First Cost.—Another prominent feature of the approaches is the construction of earth embankments to fill the spaces intervening between the concrete trestle structures. These embankments total a length of over 13,000 ft. They require about 800,000 cu. yds. of fill to bring them to the designed cross section of 26 ft. at the surface to provide a clear road width of 18 ft.; a width of 100 ft. at the base for a safe foundation body; and an average height of 24 ft. to elevate the road surface 3 ft. above the highest recorded floodwater mark. The earth material required is obtained from a selected borrow pit located on the higher ground near the edge of the swamp.

Earth Moving Operations.—Earth moving is accomplished by two trains of seven 12-yr. to 16-yr. dump cars each, run on steel tracks supported by a temporary pile-driven trestle built over the line of the fill from timbers cut while clearing the advance 200-ft. right-of-way. This temporary trestle is offset at the site of each concrete structure, and is provided with a passswitch so that, while other details of work are being carried on, the operation of the trains may be made continuous. In other words, while one train of cars is being dumped, another is being moved into position for that purpose, while yet a third is being loaded under a 2½-yd. Bucyrus 70-C steam shovel, stationed in the borrow pit. By thus co-ordinating the movements of the trains, it would be possible to move the earth at a rate of more than 3,000 cu. yds. a day. Of



Concrete Pile Construction for Trestles.

course this rate is not continuously maintained because of the necessity of frequently using the cars and tracks for transporting material and equipment for other operations along the route. If there be made a reasonable allowance for unavoidable delays from other causes, then the average recorded rate of 1,200 to 1,500 cu. yds. is about as high as could be expected.

From an unobserved position, the writer timed the loading of one of the trains and noted that 42 2½-yd. shovel loads (105 cu. yds.) were placed into the cars in 11.2 minutes. It took 3.4 minutes more to move this train clear and get the other train in position for loading. At this rate, which

appeared to be under normal conditions without hindrance, one train load could be supplied to the fill every 14.6 minutes, or something over 400 cu. yds. an hour.

The satisfactory results evidenced so far in the construction of these embankments is, in large measure, due to the excellent fill material supplied by a 48-acre borrow pit located only after a number of test holes had been sunk at various points along the edge of the swamp.

No doubt this borrow pit had some bearing upon the selection of the present route for, where it was known that earth was to be moved in such wholesale quantity, the choice of suitable materials near at hand would enter into the decision as an important factor. At any rate, the borrow pit yields an abundant supply of a natural sand-clay-gravel mixture, ideal for use in the embankments.

The problem of so alternating the lengths of earth embankments and concrete structures as to secure the most efficient results at a minimum cost, finds a satisfactory solution in this case. It was imperative that permanent structures be properly located along the route in such lengths as to provide the cross-sectional area to take care of the swamp water flow at its highest floodmark; hence the concrete design. The structures along the remaining lengths have only to serve the purpose of a durable wall, furnishing a surface capable of being maintained as a road. With the size and make-up of the embankments, together with the adequate sand bag and rip-rap protection given them at the ends of the fill sections to prevent washing, it is believed that they will meet the demands for which they were designed.

In brief, this difficult problem has been solved on a basis of sound reason—and in this connection it is not amiss to note that after limiting the more expensive concrete trestle work to the necessities of the case, the remaining portion of the swamp structure is being built at a much reduced cost—the comparative cost for equal lengths of concrete and fill work being approximately in the ratio of 8 to 1.

The Main Channel Bridge.—At the site of the main bridge the river channel is 330 ft. wide. The bridge plans provide for one steel truss draw-swing span 180 ft. in length, with a draw opening of 63 ft. to accommodate vessels navigating the river, and two through steel truss fixed spans, the whole supported on five solid concrete piers, three of which rest in the channel, with one on each bank of the river.

It is of interest to note some of the details in connection with these structures. The large center pier, designed to carry the swing span, was the first to be erected. Extensive borings had previously been made by the State Highway Department, with the result that a hard limestone rock formation was found overlaid with a 7-ft. thickness of soft shell rock deposit.

To base the pier on the limestone rock would insure an everlasting foundation, but it would first be necessary to clear away the softer shell deposit, from a depth of nearly 30 ft. in a swift current.

The tank method having been decided upon as the safest to pursue under these circumstances, a bottomless cylinder steel tank was built up to measure 22 ft. in diameter 30 ft. in height. It was well braced inside with timber struts, and when completed weighed 19 tons. In order to handle this weight, which was beyond the capacity of the largest available floating derrick, a special 60-ft. boom was made from one of the large swamp trees and strengthened with a stout A-frame fitted to the end enabled the tank to be lifted clear and then transported to the point where it was lowered into position in the center of the river. Piles were then driven around the circumference and so braced that the tank was firmly held in accurate position. A churn-drill was rigged up by suspending a heavy sheet pile from the boom, and the soft shell as loosened within the tank was removed with a clam shell bucket, until the hard limestone rock foundation was uncovered. As an additional precaution, a diver was sent down to make sure that the bottom inside the tank was clean and in all respects ready to receive the concrete mixture. The building of the pier was then begun. Concrete was lowered in buckets through thirty feet of water and gently dumped on the prepared foundation, great care being exercised in lowering and dumping, especially during the first pourings, to avoid damage by washing the particles of cement from the aggregate.

The adjacent river pier was built up in the same manner, except that a rectangular tank was used.

The first bank pier was protected by driving interlocked sheet piles around the site of the pier and the bottom of the tank thus formed was excavated with a clam shell bucket to a depth sufficient to secure a solid foundation. As a result of the satisfactory and economic use of this steel sheet piling, the same method was adopted for preparing the foundations and protecting the pourings for the remaining piers.

Method for Control of Weeds on Lawns

The following method of reducing or eliminating weeds from lawns was developed by a wide series of experiments extending over 20 years at the experiment station of the Rhode Island State College. It is described in a mimeographed bulletin of the college, from which the matter following is reprinted:

All lawn grasses require, in order to grow at their best, that the soil be supplied with plenty of plant food in the three elements found in all commercial fertilizer, namely, nitrogen, phosphorus and potassium. Most grasses and weeds also require that the soil be not sour, but Rhode Island and other bent grasses, which make an even turf and which stand close clipping, grow well in an acid soil.

The usual fertilizer employed for top-dressing lawns in the spring do not develop acidity and permit the coarsely growing weeds to crowd out the grass.

Nitrogen is commonly furnished in nitrate of soda, which tends toward an alkaline reaction. By substituting a similar amount of sulphate of ammonia, which is not more expensive, an acid condition of the soil is gradually produced which weakens the weeds while not affecting either the bent grasses or the fescues. Thus in two or three seasons the weeds will entirely disappear or, in new lawns, will never become troublesome.

The phosphorus can be applied in acid phosphate and the potash in muriate of potash as usual. Different soils require different amounts of plant food, but a good proportion for average conditions is 250 lb. sulphate of ammonia, 400 lb. acid phosphate, and 250 lb. muriate of potash to the acre. A smaller amount than this should be used on newly seeded lawns.

At present no commercial fertilizer of this mixture is on the market, but the constituents can be obtained from dealers in fertilizer chemicals and readily mixed when needed.

Precautions.—It should be noted that a too heavy application of sulphate of ammonia will injure the grass as well as the weeds, but in the proportions as noted it may safely be used as freely as the common lawn fertilizers. It is necessary that the fertilizer be distributed evenly when the lawn is dry in order not to burn the grass. Where convenient it is well to sprinkle the lawn thoroughly after applying the fertilizer. Do not, in preparing the lawn or afterwards, use lime, wood ashes, or any substance which will tend to produce an alkaline reaction.

It is also only reasonable to expect that lawns in which the weeds have for a long time had the upper hand will only slowly be brought into a weedless condition.

Summary.—Apply in the very early spring a fertilizer, as noted above, containing sulphate of ammonia, using somewhat less on new grass and, if desired, somewhat more on well-established lawns.

If not already seeded with bent grasses or fescues, sow or rake in not less than 30 lb. per acre a few days after applying the fertilizer in the spring or late in the summer.

Apply the fertilizer as a top dressing regularly each spring, in lessening amounts as the weeds disappear.

Under ordinary conditions reseeding should not be necessary for at least 10 years, but if the grass is thin reseed as originally seeded a few days after applying the fertilizer in the spring.

Farm Tenancy in United States.—Farm tenancy in the United States increased only 1 per cent during the last 10 years, according to a report made by the Institute for Research of the Land, Economics and Public Utilities. The report showed that tenants operated approximately one-fourth of the farms of the country in 1880, with a jump to 28 per cent in 1890 and to 35 per cent in 1900. A more gradual increase came in the next two decades, the proportion in 1910 being 37 per cent and in 1920 38 per cent.

Highway Views and News in Various States

Editorials and Articles From Official Publications of State Highway Departments

Highway Spillways for Carrying Flood Water

From New Mexico Highway Journal

Whatever has been the damage to roads and bridges, the rains and floods of the past season have demonstrated one thing, and that is the efficiency and permanence of the spillway.

Bridges have been washed away, piers buried beneath several feet of gravel, abutments and box culverts have been undermined, but in the main, the spillway is still with us and has served us well.

The Southwest country, with its many dry washes and arroyos of considerable width but shallow in depth, furnishes admirable locations for spillways. During 99 per cent of the year these streams carry no flow, but the other 1 per cent taxes the structures in these locations to their utmost.

The properly constructed spillway should conform to the natural stream bed of the arroyo as nearly as possible. Where the gradient of the stream is light, the problem of holding the spillway is not difficult, and a cobblestone apron and cutoff wall on the down stream side are sufficient. However, when the flow in flood time is rapid, and scour a menace to the structure, the apron must be widened and in extreme cases it may be necessary to pave the arroyo bed with riprap. A careful survey of the proposed location will reveal the necessity of these extra precautions.

The properly constructed spillway should also be well marked as to both alignment and depth of flow for the protection of the traveler. This may be done by concrete posts at stated intervals along the shoulder lines, the lowest posts being plainly marked for each foot of depth over the pavement.

The longest spillway in New Mexico at the present time is on Federal Aid Project No. 104, in Sierra County, being 610 ft. long and of concrete construction. A portion of this spillway is on an alignment curve. Project No. 104 is not yet completed, but this mammoth spillway has been given a severe test already by heavy rains in that county. It may be necessary to further protect this structure on the down stream side.

There is no doubt but that in future highway construction in New Mexico the spillway will be an economical and increasingly necessary type of structure.

Co-Operation

From Texas Highway Bulletin

Even a Napoleon cannot win a battle without the complete co-operation of his generals and his army. The highway department cannot give Texas a satisfactory state system of highways unless the county officials and the people of the counties co-operate in this justly great task which the legislature has seen fit to bequeath to the department. With the co-operation of all, the undertaking is assured of success and the beneficent results which will result will be incalculable. True co-operation is expressed in the following verses:

You have a dollar,
I have a dollar.
We swap.
Now you have my dollar,
And I have your dollar.
We are no better off.
You have an idea,
I have an idea.
We swap.
Now you have two ideas,
And I have two ideas.
Both are richer.
What you gave you have.
What you got I did not lose,
This is co-operation.

Contracts Taken Over by Bonding Companies

From Utah Highways

On three gravel surface projects the contractors have made such slow progress that the state has found it necessary to require the bonding companies to take charge of the work and proceed with the completion of the contracts.

A variety of reasons appear to have operated to cause these failures: labor shortage, due to unusual local conditions; unit prices too low to pay construction costs with the methods used; lack of proper management re-

sulting in lost motion and delays; equipment inadequate to operate effectively. Summed up, all of these causes indicate insufficient financial resources, lack of knowledge of the nature of the work and failure to properly analyze the costs.

It is the general policy of the commission to let a contract to the lowest responsible bidder, "responsible" meaning one who can obtain from an approved bonding company security equal to the amount of the contract award. The amount of the contract is based upon the unit bid prices for labor only, the state tests and selects the gravel to be used and furnishes all materials entering into the construction, other than those of local occurrence.

In these and in all other road contracts the state is fully protected and holds the bonding company responsible for the completion of the work to specification requirements when the contractor is unable to make satisfactory progress.

Such occurrences as these under consideration indicate that it may prove advisable to adopt a policy in force in a number of states of requiring each bidder to furnish a statement setting forth his experience in the work to be undertaken, his financial resources and equipment available, this information to be taken in consideration in awarding the contract.

The purpose of this procedure, if adopted, will be to protect the citizens of the state from loss in attempting a contract where it is not reasonably clear that they can conduct it with satisfaction to themselves and the state, and with a minimum of inconvenience to the traveling public.

Good Roads Are Worth Their Cost

From North Carolina Highway Bulletin

The highway is not simply a road. It is not simply a surface.

It is the assurance of the civilizing influence of better communication between sections.

It is a silent, but persistent factor for the reduction of living costs.

It is an humble, but powerful foe of ignorance for the reason that it makes easily accessible our splendid system of public schools to the people in rural districts.

It is the safeguard of our food supply. It is a guarantee to the public against the prostrating influence of industrial upheaval and interruption to distribution therefrom.

It is the popular open-air theater of enjoyment of the family.

It is the text book of nature to our people.

It is the connecting link between the home and the factory.

It is the call to open air; the great physician who makes no charges for his services.

The people who are opposed to good roads oppose them for the same reason that some people oppose our great public school system; they are not informed.

Gravel Road Construction in Utah

From Utah Highways

The growing popularity of gravel roads in Utah, constructed to federal standards, is shown by the following figures, showing mileage constructed or proposed over a 4-year period:

Year	Miles
1921	34
1922	42
1923 (program)	143
1924 (program)	200

Thirty-five per cent of the highways in the United States on the federal aid system are gravel roads. The experience gained through such extensive construction and use of this type of road has naturally led to improvement in methods and in the materials employed. Up to and during a part of the season of 1921 gravel passing a 3 in. screen could be used as a part of the base course; on Utah state roads this has been cut down by successive gradations, as experience demonstrates the superior binding qualities of smaller particles of gravel, until the maximum size now permitted in the base course is 1½ in. The top or wearing course has undergone similar modifications during the same intervals from "passing a 2-in. screen not less than 95 per cent" as we read in the old specifications, to 100 per cent passing a 1-in. screen and not less than 25 per cent retained on a ¼-in. screen.

Construction under the latest specifications will mean that much of the gravel used for surfacing will require crushing—more expensive—but highly desirable from the point of view of increased wearing qualities, the dust and fines resulting from the crushing operation furnishing binder of a high quality. The theory of the gravel road is, in effect, the same as that of

concrete, the greater the adhesion in the binding material the greater the resistance of the road to abrasion—a "clay-concrete," so to speak.

Other improvements relate to placing the gravel to facilitate distribution of sizes, and sprinkling is specified as required to assist the rolling operation to secure a thorough compaction of the gravel courses. The "feather-edge" type of section has been changed to a uniform depth for the entire strip and shoulders are required to be formed to hold the surfacing in place before any gravel is spread.

Three Years of Road Building in Kentucky

From The Kentucky Road Builder

The readers of The Kentucky Road Builder may be interested in a general statement of cost and progress of road building in the state between July of 1920 and July of 1923. During that period the total receipts in the state road fund from all sources were as follows:

Receipts	
Balance carried forward	$ 1,261,989.14
Motor license	6,431,520.62
Gasoline tax	1,398,216.63
Three-mill tax	2,171,410.51
Federal aid allotments	4,156,812.61
Counties, cities, etc., donations	2,048,417.51
All other sources	107,876.96
Total	$17,576,243.98

The total disbursements for the same period are shown opposite the principal activities of the department:

Disbursements	
$50,000 special budget (annual amount)	$ 147,759.13
$200,000 special budget (annual amount)	586,948.65
State aid construction	1,349,586.75
Federal aid construction	10,425,800.14
Convict labor construction	607,455.13
State contracts since 1920, construction	1,842,258.48
Maintenance of roads	1,479,023.80
Machinery	205,604.76
Office improvement, Frankfort	23,018.81
Miscellaneous	10,834.39
Total	$16,678,290.04
Average per year	$ 5,559,430.01

In arriving at any averages for cost per mile of doing different operations it should be borne in mind that maintenance and construction are entirely different items. For the entire period the expenditures amounted to $16,678,290.04 or an average per year of $5,559,430.01. Including federal aid, state aid, convict labor and the state contracts let since 1920, also reconstruction under supervision of the maintenance division, there were 991.1 miles of road of all types completed in the three-year period. This is at the rate of approximately 330 miles per year, or very close to 150 miles of road graded and surfaced, as there is approximately 50 per cent of the mileage reported as completed that was graded only, the surface to be applied later.

On July 1, 1923, there were 619.2 miles of all types under construction. A part of this will be completed during 1923, but probably half of it will go over to the season of 1924 for completion.

On July 1 of this year there was a total of 1,097 miles of roads under state maintenance. This is subdivided into 510.57 miles that were repaired by counties at their expense and accepted by the state for maintenance; 83.58 miles were reconstructed under the Maintenance division, either partly or wholly at the counties' expense and 502.95 were taken over from the construction division.

Up to July of this year Kentucky had received in the form of annual apportionment from the federal government a total of $8,960,154.55. Of this amount $8,197,045.68 had been applied to construction on federal aid projects.

The average cost per mile for road construction during this three-year period was less than $15,000 per mile.

Highway Maintenance

From the October News Letter of the Wyoming State Highway Department

Maintenance puts the "main spring" in good roads. Of course everyone has understood that maintenance was was a part of the program. Back in the misty minds of some who have been looking askance at the progress being made in the building of highways, has lurked the question of how good roads could be kept up once they were constructed. Some have "bet" it couldn't be done. They seem to "win" after the way the rain poured down during the past year. Never since the white man set foot in Wyoming has the Big Horn River been so high, nor has Wind River played such pranks. The highways being built for the past several years were intended to withstand just such extremes. To build well is an important factor in the matter of maintenance.

The need of maintenance we shall have ever with us. States are receiving federal aid funds with the understanding that "the states will maintain." Surely that is a fair proposition. Could anyone imagine a young man about to be married who would not enter into a compact with his dad to keep his new bungalow in perfect condition if his dad would agree to pay half or two-thirds the cost of the building?

No one wants the old system of roads again. Everyone, whether he drives a buckboard, a Packard or a Ford, should be willing to contribute a share toward maintenance.

Cost of Road Plans in South Carolina

From South Carolina Highway Bulletin

During the first six months of the year there have been turned out in the road drafting department of the state highway department 213.91 miles of road plans at an average cost per mile of $43.00, approximately.

A complete set of road plans shows the alignment of the old road and in heavier symbols the alignment of the proposed improvement together with the right of way lines; all drainage structures to be built or rebuilt; the profile of the existing ground along the center line of the survey and the elevation of the proposed road; and the quantities of material which are to be contracted for. In addition to this all topographic features, such as railroads, rivers, etc., necessary to form a complete map of the road and the surrounding country, are included.

How Long Will Timber Last?

From the October News Letter of the Wyoming State Highway Department

The question is frequently raised as to the durability of timber when left in the open.

The September Georgia Highways carries an illustration showing a wooden head board of a grave in old Midway Cemetery in Liberty County, Georgia. The board is of black heart cypress timber and bears the date "Anno Domine 1770." The carving was done by hand, and the somewhat unusual shape of the letters would indicate that the head board was made during the latter part of the 18th century. It has been constantly exposed to the elements since that time.

An Old Time Road Description

In an article in a recent News Letter of the Wyoming State Highway Department Mr. Mark M. Kelley cites the following interesting examples of early road descriptions, taken from actual county records:

"Alton's to Foot of Mountain"—

"Commencing five rods north of Mr. Alton's house on the County Road leading into ————, thence running in a westerly direction and following up the new traveled road as far as the school house of District No. 4, thence bearing to the right and running in a northwesterly direction and following up an old road that was traveled on and lead to the saw mill after passing by the ranch of..... on said road and crossing..... Creek at the south end of..... field, thence running up said creek and cross the field of J. N..... and striking the now traveled road leading to the timber on the mountain, following up said road to the foot of the first range of mountains." (Approved.)

Also: "Beginning at a point in the road running up B.....Creek known as the "F....." Road south of the "Jimmie Chandler" Chimney in B.....Creek, thence northerly and westerly by its most feasible route, passing the ranches of L. J. B....., Warden P. McL....., Mrs. William H. U....., P. C. H....., and J. B. O'W..... and Wilson School House." (Approved.)

Thanks to the development of safe and sane highway engineering, such road descriptions are no longer approved.

Traffic Census of Colorado Highways.—The first traffic census taken in Colorado during the last five years was started by the State Highway Department on the Denver-Fort Collins-Cheyenne road on July 1. A crew of 20 enumerators was employed in the work, with J. E. Furlong, as the chief census director. At most of the stations the count covered a period of eight hours each day, but at two or three junction points a 24-hour check was made. Every main highway and mountain pass in the state was covered by the enumerators.

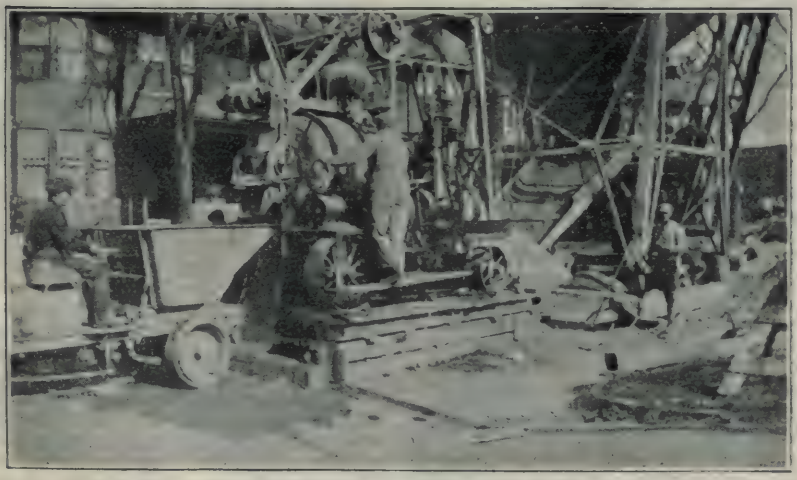
Labor Saving Arrangement for Alley Paving

An interesting construction plant set-up is being employed by the Otis Cement Construction Co., Detroit, Mich., on an alley paving job in that city. A central mixing plant is used and the paver is charged directly from the storage bin, which in turn is loaded by a Little Giant gasoline operated crane and clamshell. The wet mix is transported by tructractors. The bin is a Blaw-Knox with adjustable measuring batch hopper which discharges directly into the skip of the mixer. This method has eliminated many laborers and has kept the mixer working at capacity all of the time.

The man power used at the mixing end is as follows:

Little Giant Crane	1 operator
Blaw-Knox Hopper	1 operator
Koehring Mixer	1 engineer
Koehring Mixer	1 fireman
Cement men	2 men
Utility men	2 men
Total at mixing end	8

View of Hopper Showing Chute for Loading Mixer Skip.



The Charging, Mixing and Transporting Ends of the Job.

On the paving end of the job, two finishers together with four helpers are employed. Four tructractors and four drivers deliver the wet mix. With this outfit the contractor is averaging 900 sq. yd. of 7 in. concrete per day.

Zoning in the United States

More than 22,000,000 people, comprising 40 per cent of the urban population of the United States, live in 183 zoned cities, towns and villages, according to a statement made public last week by the Division of Building and Housing of the U. S. Department of Commerce.

During the first eight months of this year 54 municipalities, with more than 6,500,000 population, have adopted zoning ordinances. This indicates the greatest progress in zoning that has ever been made during a similar period. More than two-thirds of the 183 zoned municipalities have been zoned since September, 1921.

Revised figures show that on Jan. 1, 1923, 129 municipalities had adopted zoning regulations. During the year 54 more, some large and some small, located north, south, east and west, have been added to the list. Of the 68 cities in the United States with over 100,000 population, 36 have zoning ordinances in effect. Chicago, Baltimore, Pittsburgh, Kansas City, Mo., Seattle, Providence, Columbus, Worcester, Grand Rapids and Youngstown are among the larger cities which have adopted zoning ordinances this year. The smallest community to adopt a zoning ordinance in 1923 had only 420 inhabitants, according to the last census. Twenty-one towns and villages of less than 10,000 inhabitants adopted zoning regulations in 1923. Seventeen communities with 10,000 to 50,000 population, and 16 cities with more than 50,000 population also zoned during the year.

In the number of places zoned, New Jersey leads with 51; New York is second with 30; Illinois, third with 23; California, fourth with 17; Ohio, fifth with 13; Massachusetts, sixth with 11; Wisconsin, seventh with 10; and Missouri, eighth with four. Indiana, Kansas and Michigan have three each; Rhode Island and Washington have two each; and Georgia, Maryland, Minnesota, Nebraska, North Carolina, Pennsylvania, Tennessee, Texas, Utah and Virginia have one each. The District of Columbia also is zoned.

More new state zoning enabling legislation has been passed in 1923 than usual, and the standard state zoning enabling act which was prepared by the Department of Commerce, was used to a greater or less extent in most of the laws. Connecticut, Delaware, Iowa, North Carolina, North Dakota, Oklahoma, Pennsylvania and Wyoming passed important zoning enabling acts, and a number of other states passed legislation supplementing or amending existing laws. The State of Wisconsin has passed an act granting to counties the power to zone.

The complete list of zone municipalities, as of Sept. 1, 1923, with references to the state acts under which zoning is permitted, may be obtained from the Division of Building and Housing of the Department of Commerce, Washington, D. C.

42 Ft. Concrete Pavement Laid in Four Sections

A 42 ft. wide concrete pavement on Commonwealth Ave., Boston, Mass., was constructed in four longitudinal strips, each 10 ft. 6 in. wide. These strips were laid in alternate pairs, the mixer traveling on the subgrade and placing a strip on either side as it advanced. When the farther end of the improvement was reached the mixer was brought back, and traveling on the surface of one of the strips already in place, laid the two remaining sections. The total width of the pavement is 50 ft., this including granite block futters 4 ft. wide on each side. The concrete has a uniform thickness of 7 in. and is reinforced with ½ in. square steel bars, both longitudinally and laterally. The bars are placed on about 2 ft. centers each way and are wired together into a mat with clips at all intersections. The concrete was first struck off with a template resting on the side forms after which the surface was rolled with a light metal roller and then belted with a canvas belt. After initial hardening had taken place, the surface was scored with brooms in order to afford a better grip for traffic in any sort of weather.

Intensive Highway Maintenance in North Carolina

Methods Employed by State Highway Commission Described in North Carolina Highway Bulletin

By W. E. HAWKINS
Maintenance Engineer, North Carolina Highway Commission

For all state highway improvement, both construction and maintenance, North Carolina is divided into nine districts. In each district there is a district engineer in charge of all highway work. Under him is a maintenance engineer, who is in immediate charge of all maintenance.

State Divided Into Nine Districts.—The district engineer is responsible for the maintenance work in each district, but there is such control from the state highway commission and state highway engineer that certain uniform standards are maintained, costs regulated, and a uniformity in work secured throughout the state as a whole. Each district is divided into from two to three divisions, and the maintenance engineer has as his assistants the supervisors, who are experienced, practical road men, assigned to each division, who travel within that division, giving instructions and keeping in touch with the various patrolmen from time to time.

The state maintenance engineer travels from district to district making inspections with the district engineers and giving suggestions and advice on methods, practice and standardization of all maintenance.

Each district engineer is under bond, and is allowed a sum of money on deposit to pay all current bills and payrolls. Weekly vouchers are made out in the district office for all payments made, and sent with the approval of the district engineer to the headquarters office. The auditor of the commission scrutinizes and checks these vouchers very closely, and upon approval, a check is sent to the district engineer reimbursing him for the amount of the voucher.

As promptly as possible after the various sections of the state system have been established by the commission, each district engineer was notified accordingly and given instructions to start intensive maintenance improvements at once.

Start of Patrol and Gang Systems.—Plans were made to inaugurate the patrol and gang system of maintenance. The local situation of each road was considered, and sections laid out from 15 to 20 miles in length, which were placed under the supervision of a patrolman. Considerable difficulty was experienced at first in obtaining sufficient and satisfactory equipment to carry on the work.

The large number of trucks and tractors, which had been obtained from the U. S. Government as war surplus material, had been rented to the counties during the years 1919 and 1920, to assist in the maintenance under the old county system. When these trucks were returned to the state in the early part of 1921, most of them were found to be absolutely useless. General overhauling and repairs had to be made before any truck was in condition for use. Various kinds of machinery had to be ordered, such as heavy road machines with scarifier attachments, smaller type road machines for light work, drags, and many small tools and other similar equipment.

Considerable trouble was experienced at first in getting sufficient machinery and tools to equip each patrolman. In the course of time each patrol was equipped with a motor truck of from 3½ to 5 tons capacity, a 2-way drag, and necessary small tools. A light road machine was allotted to each two patrolmen.

Organization of Floating Gangs.—Floating gangs in each district were organized for grading and bridge repairs. The grading gang consisted of a foreman, laborers and a cook. They were equipped with a large tractor, a heavy road machine with scarifier attachment, and portable shanty houses. This outfit traversed one complete district at a time, shaping and putting into condition many miles of narrow unimproved earth roads of topsoil and various other types which had been taken over for maintenance in each district. The bridge floating gang consisted of a foreman, laborers, a cook, and portable shanty houses. The organization of this gang was made necessary because of the deplor-

able condition of the bridges found in each district. Timber bridges were repaired, widened, reconstructed, and in a number of cases an entirely new bridge was built. Many steel bridges had to be scraped, painted, refloored, and reconstructed throughout. A repair shop crew was organized in each district so that immediate minor repairs could be made to the motor trucks and cars in case of emergency.

Putting the Roads in Shape for Maintenance.—When a system of roads is accepted for maintenance such as those in North Carolina, an intensive maintenance plan is the only solution for immediate service to traffic. The unimproved dirt roads were widened and reshaped, the surface and side ditches reconstructed by the roadway floating rangs, and overhanging timber and brush cut. The top-soil, sand-clay, and gravel roads were rebuilt by scarifying the surface, hauling and adding new material and reshaped by the roadway floating outfit or with the patrol truck and light road machine. On other types such as concrete, asphaltic concrete, penetration macadam and other hard-surface pavements, the surfaces were repaired, shoulders rebuilt, curves widened, side ditches cleaned, and guard rails erected and painted.

After six months of intensive work, approximately 5,000 miles of the state system were being maintained in such a manner that the state highway commission was receiving commendation from all sections of the state. The state-wide patrol organization was so well planned that after each and every rain the patrolmen have dragged and put in shape approximately 4,000 miles of top-soil, sand-clay and gravel roads.

In accordance with the provisions of the state road law, the state system has been distinctly marked with route signs, as well as distance and warning signs. Standard signs, such as route markers, and those donating distance, county line, danger curve, cross-roads, railroad grade crossing, school zone, drawbridge over large rivers, and district line signs are in use over the entire state. In addition, patrol section signs have been erected on the entire system.

Maintenance and Construction in Co-Operation.—The maintenance and construction work in each district are in thorough co-operation. It is therefore possible to anticipate the starting of construction work on a project. When necessary the road is closed to traffic, and immediate attention is given to the detour road, making repairs and placing it in conditon for travel at all seasons of the year. The detour roads are constantly maintained during the construction period, and a standard series of signs erected adequately directing traffic from one end of the detour to the other.

A map of the state has been issued with route numbers designated, and the entire state system has been marked in a manner that is easily discerned by the traveling public.

There are registered in the state more than 182,500 motor vehicles traveling an aggregate mileage within the state of not less than nine hundred million miles per year. This represents a tremendous investment, the utilization of which depends entirely on the development of the roads over which they travel. Consideration of this and the realization of the necessity for the state-wide maintenance throughout the state led to the organization of what we believe is a highly efficient system of maintenance, and one which has brought wonderful results in the short time that it has been in operation.

1,000 Men Maintain 5,500 Miles of Road.—At the present time there are about 1,000 men engaged in the upkeep of the state system. These men are responsible for the condition of over 5,500 miles of road on which they are working daily. The machinery and equipment in use and the mileage of roads, including detours, at present maintained in the state are as follows:

Trucks, 437; tractors, 37; road machines, 197; drags, 327; miles maintained, 5,577.

The result of the maintenance improvements in the past 18 months has made a strong impression upon the people of North Carolina, and has been favorably commented upon by many people from other states, and from foreign countries as well.

It has been demonstrated by North Carolina assuming control of a large mileage of highways for improvement, and by the establishment of immediate intensive maintenance on these highways that the public at once realizes something is being done. The adoption of the combination patrol and gang system of maintenance, employing motor trucks and tractors for

all operations demonstrated to each and every section of the state that results were being accomplished every day. The same standard of work and uniformity of practice was maintained throughout the entire state, and combined with the tremendous extent of the operations, gave immediate and better service to traffic and satisfied an impatient and jealous public who did not expect to see the results realized in so short a time.

Causes of Waves in Asphalt Pavements

Report Presented at International Road Congress, Seville, Spain

By PREVOST HUBBARD,
Chemical Engineer, The Asphalt Association

Waviness is not an inherent characteristic of asphalt pavements as evidenced by millions of square yards of satisfactory surfaces varying from 1 to 40 years or more in age and subjected to all conceivable conditions of exposure and traffic. The formation of waves, particularly in pavements of the fine aggregate type does, however, occur to a suffifficient extent to warrant a thorough investigation of the subject with the idea of securing data which will enable highway engineers to prevent such defects in future construction. Such an investigation has recently been undertaken by the U. S. Bureau of Public Roads in co-operation with the Asphalt Association and the cities of New York, Philadelphia, Baltimore, Washington and Detroit.

Traffic is, of course, the most direct cause of wave formation, the thrust of vehicle wheels tending to re-arrange the mineral particles of the paving mixture from the surface down. Under certain conditions the mixture is therefore shoved into humps or waves, usually at a right angle to the direction of traffic, although at curves and intersections, waves due to the side thrust of vehicles are sometimes noted. When the pavement is sufficiently wide to allow two well defined lines of traffic, transverse waves are most prevalent near the gutter where most of the horse drawn and other slow moving vehicles travel. Even on comparatively narrow pavements waves seldom extend entirely across the surface. While it is probably true that the impact of fast-moving traffic accelerates wave formation, once started, or may be directly responsible where irregularities in contour first existed, slow-moving heavily loaded vehicles are believed to be the predominating cause.

There are a number of conditions which tend to promote wave formation which are being given careful consideratoin in the government investigation. These are as follows:

Foundation Faults.—Lack of support from below causing local settlement of the foundation.

Uneven contour in foundation causing variable thickness of asphalt paving mixture and consequent differences in compression.

Very smooth foundation which may promote slipping of the asphalt paving mixture over its surface.

Inferior Paving Mixture.—Use of too soft an asphalt cement for the climate, traffic, or the grading of the mineral aggregate.

Use of too much asphalt cement in the paving mixture.

Poor grading of mineral aggregate, which creates instability of the paving mixture irrespective of the consistency and percentage of asphalt cement with which it is mixed.

Use of an excess of rounded particles of mineral aggregate in the paving mixture.

Construction Faults.—Uneven contour due to faulty spreading, raking or rolling of the paving mixture during construction or lack of uniformity in the composition of the paving mixture.

Lack of proper initial compression during construction, which may be due to use of too light a roller, too little rolling, to the mixture being too cold when rolled, or too great thickness of course for a single rolling operation.

Faulty repairs to service openings.

Exterior Causes.—Absorption of an excess of oil or gasoline drippings, causing undue softening of the asphalt cement.

Gas leaks from mains below the pavement structure, causing undue softening of the asphalt cement.

The Municipal Traffic Problem

Suggestions for Relieving Street Congestion Given in Address Sept. 21 at Convention of Motor and Accessory Manufacturers' Association

By H. W. SLAUSON,
Engineering Service Manager, Kelly-Springfield Tire Co.

I believe there is one practical suggestion which should be adopted by every city in which street congestion is serious. This relates to the traffic confusion which is so greatly aggravated by the trolley, which not only controls the speed of travel on its own track but which may also bring sev- complete halt every time it stops to take on or discharge passengers—and during the rush hours when automobile congestion is greatest, this trolley interference is at its maximum effectiveness.

Most of us longer agree with the radicals that the trolley should be legislated out of existence. Heretofore it has represented a legitimate investment. It pays, when it is able, a high franchise and tax rate and is frequently compelled to keep the pavement between its rails, and for a certain distance on either side, in better condition than the city maintains its own streets. Furthermore, after a severe snow storm it is frequently only the trolley right-of-way which has been plowed, swept and made passable for other vehicles.

Traffic Controlled by Trolley.—But, where the trolley should have the privilege of controlling only a single line of traffic, in reality, as has already been pointed out, it controls every line of traffic between its rails and the curb and will continue to do so as long as every street corner becomes a station for the arrival and departure of passengers.

To lay the rails at the side of the street close to the curb would greatly lessen the congestion of moving traffic, but is impractical because no motor cars could be parked at the curb. The elimination of the rails by the substitution of rubber-tired trolley buses with flexible connections with the overhead power wires has been tried successfully. But, in many instances, these rails must be used for long distance and suburban traffic, and at any rate, the tracks, conduits and third rails represent an investment which many trolley companies will not willingly throw away. Therefore, inasmuch as it is the frequent stops of the trolley which add so greatly to traffic congestion, let us reduce the number of these stops as much as possible.

Short Haul Traffic by Trolley Busses. — Trolley transportation should prove a supplement to, rather than a detriment of, street traffic. Why could not existing trolley companies use their rail equipment for long distance hauling with no intermediate stops to take on or discharge passengers? The short haul traffic could be handled by means of supplementary motor buses owned by the trolley company and operated either by gasoline engines, storage batteries or flexible connections with the overhead trolley wires. Such buses could stop at the street corners as easily as a private automobile and could carry all of the local traffic with arrangements for transfers at points one or two miles apart at which the rail-bound trolley cars could stop.

The rail-bound trolley, with its infrequent stops, could then travel as fast as its own line of traffic would permit. Under this arrangements passengers could be carried more quickly either by the short haul bus or the express trolley, than is possible under present conditions of traffic. It may be argued that the increased number of buses would so add to highway congestion as to neutralize their benefit, but they could replace almost an equal number of trolley cars now used for the short haul traffic, and because of their ability to pull directly up to the curb to receive and discharge short haul passengers, and to weave in and out of traffic without restriction to rail, I am very positive that the carrying capacity of our streets could be materially increased.

The Accommodation of Stationary Traffic.—But traffic cannot keep moving continuously; cars are on the street because they have some definite destination in view and this brings us to the most serious of our municipal

problems—stationary traffic. If we adhered to the letter of the non-parking restrictions, the 10-minute parking limit signs and the admonitions of some of our city court justices, we could not even stop our car for lunch.

It is not the province of this discussion to describe the various means employed in many of our cities by which parking space may be secured. Diagonal parking, parking in the center of the street, parking with wheels directly against the curb, and side parking are methods entirely dependent upon local conditions.

Some cities are setting aside public squares and parks for the accommodation of stationary traffic. In other cities, large department stores maintain a free garage for their patrons with a service which includes bringing the car to the door when the customer is again ready for it.

But these attempts to improve conditions can be but temporary makeshifts of a situation which is inherently and basically wrong. Ten years ago we were all talking of the saturation point and of the continued ability of the country to absorb new automobiles, and we little dreamed that the real saturation point was the ability of our streets to accommodate the cars already in use.

I am not a close student of traffic conditions and I have no statistics other than those based on daily observation, but I ask you if it will not be absolutely impossible to accommodate on two dimension roadways, occupants of cities who are continually living in three dimensions, for our cities are no longer planes, they are cubes; the third dimension is used by every architect, building contractor and real estate man who wants to add to the value of his property through its ability to accommodate more human beings.

Traffic Density.—Just think what it means, for example, when a 20-story office building or apartment house is erected on a certain site. Such a building may well occupy an entire block and may easily replace 30 or 40 houses, each of which accommodates one or two families. If each family owned a car and if each entertained a guest simultaneously who also came in a car, there would still be room at the curb for the maximum number of 75 or 100 cars involved. Now when these houses are demolished and we add the third dimension to this block in the form of the 20-story apartment house, we may find 200 or 300 families occupying the ground space which formerly accommodated 30 or 40 families, but under modern conditions of construction and planning, the car parking space has not been increased and there is still no more room at the curb for the cars of tenants and friends than was the case when three-story single dwellings occupied this block.

What is one of the first items that the architect considers when designing his buildings? He calculates the total area of floor space, estimates the number of persons who will be accommodated on each floor and then allots space for an adequate number of elevator shafts to take care of the vertical traffic. No well-designed and well-managed building will permit of undue elevator congestion even during rush hours, and in consequence far better provisions are made for this third dimension traffic than are available for the tenant of that building whenever he desires to travel in a horizontal direction. Such a tenant, after having been whisked rapidly down to the ground floor, may find that his wife, his chauffeur, or whoever else may be driving his car down for him, have been unable to find any parking space near the building and has been forced to drive around the block continuously. This "merry-go-round" parking is becoming the only solution of the problem in certain sections of our cities.

Here again, we are confronted with the absolute necessity of adding the third dimension to our parking spaces as well as to our highways. We have added the third dimension to our rail-controlled city traffic in the form of elevated structures and subways, but we have as yet found no satisfactory solution other than vague plans, to the problem of securing the third dimension for motor driven traffic, and this traffic relief is vitally needed and must therefore be susceptible of immediate application to existing conditions. It is all very well to plan for the ideal city of 100 years from now, but the problem is not one for our children or future generations to solve, it is one for us here and now.

Problem of the Stationary Car.—I firmly believe that the problem of the stationary car is far more serious than that of the moving vehicle. The

seriousness of the situation lies not so much in present conditions as in the fact that we are doing nothing to prevent a very serious aggravation of these conditions within the next two or three years. Possibly a remedy must be brought about by legislation. It is true that there are already too many laws, but legislation which will insure adequate parking space for the cars of the future is far better than legislation which will prevent the efficient and effective use of the cars already in operation.

The automobile is too effective a tool to have its efficienty curtailed in the slightest by half-baked ideas such as have already been proposed, and which have as their object a reduction in the number of cars which shall use the streets and a restriction of the areas in which they may be kept. You cannot legislate crowds and lawful pedestrians off the sidewalks and it would be equally ludicrous or impossible to prevent highway congestion by saying that cars or trucks belonging to certain individuals shall not be used except, possibly, under given conditions, such as certain hours of the day or certain days of the week.

We must get at the fundamentals and so arrange and design our cities that, as to accommodate stationary and moving traffic will grow in the necessary proportion. Therefore, the blame for traffic congestion in reality lies with those who are responsible for population congestion and to them we should look for the remedy.

Examine the surrounding street of any large apartment house or office building. We find that such a building, while of course not gasping for air, is literally gasping for parking space. It has reached out its tenacles in all directions and has pounced on every street radiating from it as a center in order to furnish parking space for the cars of its tenants and customers. Nearby private houses which may boast of but one automobile, have their entrances blocked by the cars of those doing business in that building. A nearby public garage is hardly the answer to the problem, for this in itself would occupy valuable ground area and would not be used by those who came to work early enough to find sufficent parking space near the entrance to their building.

Parking Space in Large Buildings.—My proposal is merely that, as every modern building is required to devote a certain proportion of its area to elevator and fire escape requirements, so in the large buildings of the future we should require that they furnish adequate parking space within themselves. This will employ the third dimension—which is the cause of traffic congestion—as a means of relieving that very congestion. This is not so difficult as it might sound, for one sub-cellar or lower floor of the building which may be connected with the street by ramps, could be made to furnish automobile storage space equal to at least 5 per cent of the available rental area of a 20-story building. This would, of course, reduce the rental return of the building by 5 per cent, but if department stores have found it advantageous to rent or construct free garages for the benefit of their patrons, the owner of an office building or apartment house would find it equally "good business."

But we are not considering good business from the aspect of the real estate man. Zoning laws of our cities which have regulated the height of our buildings in order to preserve the architectural beauty and give adequate light to the streets below, have also served to reduce the total gross receipts which may be obtained from a building occupying a certain plot of ground. On the other hand, the benefits to the tenants of the entire neighborhood has been such that net revenues have not been decreased and landlord and tenant alike have been benefited.

Third Dimension Parking.—We carry out the same principal of the of third dimension parking in our suburban homes where many garages are built of fireproof construction directly in the house, as a part of the cellar. Apply this same idea to an office building, making the storage space formed available upon payment of a small fee to every tenant who has occasion to leave his car in this vicinity for more than, say, 30 minutes, and you will find an automatic solution of the parking congestion problem which will keep pace with the growth of the city. The curb space will then be left free for the cars of clients, customers and others having occasion to leave their vehicles for only a short time.

Dirt Road Maintenance in Mountainous District

Methods Used on State Highways in Sierra Nevada Mountains, California, Described in Pacific Engineer

By R. E. PIERCE
Assistant Engineer, Division III, California State Highway Commission

The state highways which cross the Sierras reach elevations ranging from about 7,000 ft. above sea level to nearly 10,000 ft., the lowest pass being the northern or Auburn-Truckee summit and the highest being the Tioga or southern pass. Ranging in elevation between these comes in order from north to south: Myers Summit, Carson Pass, Ebbetts Pass and Sonora Pass.

Unusual Conditions of Mountain Road Maintenance.—The maintenance of these mountain roads is subject to unusual conditions. During the winter heavy snow fall is characteristic of this region; as much as 30 ft. on the level has been measured and over 100 ft. has been known to fall in a single season. On the lower slopes extremely heavy rains fall. On the higher parts of the mountains, the snow lies all winter and combined with the rain on the lower reaches makes these roads closed to travel on the average from about the first of November until the first of June. This varies considerably, depending on the season and the location; the higher summits being closed for a longer period. This entails a heavy concentration of maintenance work during the summer months. The crews start work on the roads as soon as they are sufficiently dry in the lower stretches to grade and follow up below the melting snow as closely as possible in order to get the benefit of the moisture in the soil.

Grading, Dragging and Sprinkling.—The principal use of the grader is to open up the ditches, and crown the road, and where soil conditions are favorable in places where widening is needed, an effort is made each season to cut farther into the bank to widen the roads as the grading proceeds. The grading is followed by dragging and if the first grading is properly done, frequent dragging should suffice to hold the road in good shape under normal conditions. Where the road consists of nothing but the natural soil, in the dry air of this region, it generally becomes very dusty early in the summer and cuts up under travel. Where travel is heavy and soil conditions bad, a considerable amount of sprinkling is done with beneficial results. The effects obtained depend on the character of the soil, one having a large percentage of clay naturally holds, while a sandy soil without binder has little clinging quality during dry weather. In wet weather the conditions are reversed. Dragging in connection with sprinkling is a help in preventing "pot holes" and corrugated or "wash board" effects.

Over some of our mountain roads where a suitable surfacing material was available, some stretches have had a top dressing of gravel, disintegrated rock or crushed rock. This generally has had the effect of reducing the maintenance and has prevented the dust nuisance without having recourse to frequent sprinkling. Granite sand has proven unsatisfactory to make a good summer road; a number of stretches on a heavily traveled road have been treated successfully with a light asphaltic oil applied hot, after the road had been shaped up.

Clearing Up After Winter Storms.—When the crews first start the early spring work, it is necessary to go ahead of the grading, clearing trees, rocks, etc., which the winter storms have left on the road. This is sometimes a serious task; on the Big Trees road alone, in the spring following the severe wind storm of Thanksgiving, 1919, over 100 trees had to be removed from this road.

Where the roads run through timber, it is necessary to first run the grader lightly over the road to remove the leaves and pine needles which cover it, in order that they will not "ball up" is the dirt during grading operations.

Where the soil is rocky, considerable raking is necessary following the grading to get the rock off the road. Another continual expense to the state each year is clearing the roads of rocks thrown down by the numerous bands of sheep and herds of cattle traveling mountain roads to and from summer pasturages.

In relocating these roads it is to be

hoped that where the old roads are abandoned for public travel, that it will be possible to persuade the stock owners to use these for their stock in crossing the mountains.

Drainage Provisions.—Usually near the first of October, the maintenance crews give a final grading and an especial effort is made to provide as amply as possible to handle the drainage. This is very important on the steep grades which prevail, as the snow melts off rapidly and has the unfortunate habit of clogging up ditches and drains and causing the water to run down the middle of the road, doing more or less damage. When the highway commission first took over the mountain work very little provision had been made for drainage on most of the roads, but this defect is being remedied as fast as funds will permit. In the meantime, owing to lack of culverts, it has been necessary to provide water breaks across the roads on steep grades at frequent intervals in order to turn the water. These breaks should be placed in the fall as the crews leave and are of course objectionable to anyone traveling the roads. A man who had occasion to cross the mountains in an automobile after the water breaks were placed had a letter printed in a San Francisco paper, stating that he would like to use a wrench on the head of the person who placed them. Lack of understanding of the conditions alone could excuse such a letter. On the lower portions of the mountain roads where the snow fall is light, culverts properly placed make it unnecessary to place such contrivances. However, where the snow fall is heavy and remains on the ground for months it is still necessary to place some water breaks in the critical places, and it will probably be impossible to abandon this temporary device unless the roads are paved.

Early Opening of Roads in Spring.—In the spring on some of the heaviest traveled roads, an effort is made to force the opening of the roads early through the snow by sprinkling the snow with sand or dark soil. This holds the sun's heat and very materially hastens the melting of the snow. In connection with this plan tractors are run over the snow and trucks have been towed through behind the tractor, for if a track is once cut through to the ground, the melting of the snow is hastened.

The greater portion of these mountain roads have never been laid out by modern engineering methods, and consequently there is much room for improvement. Each season some improvements in line or grade or both are made which require no especially expensive work; this is where the good "horse sense" of the road superintendent comes to the front and it is gratifying to see what an excellent line and grade can be run by "eye" by some of the "old timers."

The superintendent in charge of the maintenance of the mountain roads should be men of good judgment, able to lay out work from past experience and be ready to rush grading and dragging at critical times such as late spring or early fall rains. Each season should show work of a permanent nature which will mean a better maintained road each succeeding year.

Planks on Sub-Grade Speed Up Paving

In constructing a concrete pavement on the Laurinburg-Maxton Road in Scotland County, North Carolina, operations were speeded up by plank runways laid on the subgrade, according to an article by P. A. Jenks, Resident Engineer, in the North Carolina Highway Bulletin. After the fine grading had been completed, the subgrade was rolled, forms set, and usually kept about 200 ft. ahead of the mixer. After the forms were set the sub-grade was moistened and rolled again. On account of the sandy condition of the soil, and material wagons cutting up the prepared subgrade, enough planks were laid ahead of the mixer to care for a day's run.

At first the contractors thought these planks would be of no great advantage, but since have found them to be of economical value, in so much that a saving of time has been effected by their use, and the small expense necessary to lay these planks, balanced by keeping the mixer in operation longer, wear and tear on the carts, and temper of men and mules. The drivers made better time in arriving, depositing and getting away from the skip, and a large expense was also saved in re-preparation of sub-grade before depositing the concrete.

Regulation of Traffic in City of 100,000

Methods Employed at Grand Rapids, Mich., Described in City Manager Magazine

By FRED H. LOCKE,
City Manager, Grand Rapids, Mich.

We have endeavored to keep abreast of the ever increasing traffic problem by the most improved methods obtained from our own and other cities' experience.

The city has set aside six main arteries out of the business portion of our city known as "Through Traffic Streets." By this is meant that traffic on these streets has the right of way over traffic on intersecting streets. All traffic desiring to cross or enter these streets is required to stop before so doing. By the use of this method, we are able to expedite the movement of traffic in and out of the business portion of the city more rapidly and with greater safety than any method we have as yet been able to devise. Very few accidents are reported at these intersections, most of the intersection accidents occurring where there is less regulation.

In addition to "Through Traffic Streets," we have designated quite a number of dangerous crossings as "Stop Corners." This has been done in cases where there is considerable traffic each way at the intersection and where neither street justified through traffic designation. By requiring traffic to stop before crossing or entering these dangerous intersections we have eliminated a great many accidents and have materially increased the movement of traffic.

An Effective Warning in the Line of the Driver's Vision.

An Intersection Diagram Used for Traffic Regulation in Grand Rapids.

We have just installed an automatic signal system on our main thoroughfare by suspending signal lights over the center of each intersection and being controlled from one central automatic and manual switch. The purpose of this system is to speed up traffic by opening up this street for a

distance of ten blocks simultaneously and permitting the flow of cross traffic at alternate periods.

I realize that every city manager has the traffic problem confronting him and each individual city has its own peculiar situation that must be solved as conditions may warrant.

Cities with narrow streets and with no parallel streets to aid in carrying the traffic have a more difficult task in caring for this problem than the city with parallel and wide streets where traffic regulation can be handled to a better advantage.

In the congested portion of the city, we have limited parking zones, limiting parking on car line streets to one-half hour and on other streets to one hour, and we are contemplating another zone outside the present one hour parking zone limiting parking to two hours.

We have proven to our satisfaction that the use of paint on the street surface for guiding traffic aids very materially in avoiding accidents caused by the cutting of corners by vehicles.

Annual Meeting of Advisory Board on Highway Research

The third annual meeting of the Advisory Board on Highway Research of the National Research Council will be held at the headquarters of the Council in Washington, D. C., on Nov. 8 and 9, 1923. The program calls for the following reports and addresses.

Report of T. K. Hatt, Director.

Report of Committee No. 1, Economic Theory of Highway Improvement. Chairman. Professor T. R. Agg, State College of Iowa.

This report will include a statement of the status of research upon economic theory of grades, rolling resistance, air resistance, tire wear and operating costs, with suggestions for future work.

Report of Committee No. 2, Structural Design of Roads. Chairman, A. T. Goldbeck, U. S. Bureau of Roads.

This report will include a summary of the findings of the Bates Road Test, the Pittsburgh Road Test, and the Bureau of Public Roads experiments, as a basis for a plan of future researches. The new project for research upon the relation between the traffic unit and the design of slab will be discussed as a basis for the inspection of the project now under way at Arlington. The research data on fatigue of concrete will be evaluated.

Report of Committee No. 3, Character and Use of Road Materials. Chairman, H. S. Mattimore (Pennsylvania Highway Commission).

The report of committee No. 3 will include a review of the data upon the relation between strength of cores and moulded specimens; the significance of the Talbot-Jones rattler; the determination of the amount of cement in hardened concrete; methods of test to avoid defects in concrete roads; significance of modulus of rupture and of absorption of concrete; the design of bituminous mixes; all for the purpose of determining need for future research.

Address: Objectives of Highway Research — Thos. H. MacDonald, Chief, U. S. Bureau of Public Roads.

Highway Research Work of American Association of Land Grant Colleges—Dean Anson Marston, Iowa State College.

Report of Committee No. 6, Highway Finance. Chairman, Dr. J. G. McKay, U. S. Bureau of Roads.

The report of Committee No. 6 will include a study of the effect of highway improvenet on land values in four Wisconsin counties, and describe research work on highway finance now under way in several states.

Research Program of North Carolina Highway Commission—Chas. M. Upham, State Highway Engineer of North Carolina.

Report of Committee No. 4, Highway Traffic Analysis. Chairman, Geo. E. Hamlin, Connecticut Highway Commission.

This report will include a discussion of the value of traffic surveys in determining the allocation of construction and maintenance funds in the development of a state highway system, and a description of the organization of such surveys with an estimate of the cost.

Report of Committee No. 7, Maintenance. Chairman, W. H. Root (Iowa Highway Commission).

The report of Committee No. 7 will include a discussion of research upon the use of gravel mulch, upon corrugation in gravel roads, and other topics of interest.

Schedule of Fees for Canadian Engineers

Schedule of Minimum Charges for Members of Engineering Institute of Canada in Private Practice, or Acting as Arbitrators or Experts in Court

The Committee on Classification and Remuneration of the Engineering Institute of Canada has recently made its report on fees for special work, particularly that of a consulting engineering nature. The report was accepted by the Council on behalf of the Institute as a guide for minimum charges to apply in the absence of a definite agreement, strong recommendation, however, being made that engineers in practice should make specific arrangement in every case. The report which is printed in the October Journal of the Institute, follows.

The following schedule shall apply in absence of any specific written agreement between the professional engineer and his client.

Ordinary Consultations.—For consultations which do not necessitate a written report, the charge to the client shall be established in accordance with the time spent. The basis shall be a professional day of six hours remunerated at the rate of $50. Charges for fraction of a day shall be made as follows, namely, $30 for one-half of a day, and for shorter time $15 for the first hour or fraction of an hour, depending on the importance of the consultation.

Written Reports, Valuations, Arbitrations and Expert Testimony.—For investigations or study of a project with preliminary report based on reconnaissance only and not involving detailed surveys and preliminary plans, or for investigations or study of a report, prepared by another engineer accompanied by a report on the subject, for study and report on questions in litigations for work as valuator or as arbitrator, or for preparations and depositions before a court of justice or a board of arbitration, or for attendance or evidence in Court during an inquiry, the engineer's fees shall be $50 per day. The client will pay besides the above, all out-of-pocket expenses incurred by the engineer in connection with the work, and shall also pay for all salaries paid for by the engineer to his assistants together with an additional sum equivalent to 100 per cent of the said salaries to cover office and overhead expenses. The client shall deposit with the engineer before the commencement of the investigations an amount equal to the estimated out-of-pocket expenses thereon.

Written Reports with Preliminary Plans and Estimates of Cost Preparatory to the Preparation of Construction Plans and Specifications.—For the preparation of a written report on a project with surveys, investigations, studies and conferences, and including preliminary plans and estimates of cost, the engineer's fee shall be based upon a percentage of the estimated cost of the project as follows: Where the estimated cost is $50,000 or less, 2 per cent, and not less than $100; over $50,000 and not over $100,000, 1¾ per cent; over $100,000 but not over $500,000, 1½ per cent; over $500,000 but not over $1,000,000, 1¼ per cent; over $1,000,000, 1 per cent.

In addition to the above fees the client shall pay all out-of-pocket expenses incurred by the engineer in connection with the work, and shall also pay for all salaries paid by the engineer to his assistant together with an additional sum equivalent to 100 per cent of the said salaries to cover office and overhead expenses, the client shall deposit with the engineer before the commencement of the investigation an amount equal to the estimated out-of-pocket expenses thereon, and pay to the engineer further sums from time to time as he may request to cover the salaries of assistants actually employed in connection with the project.

Preparation of Construction Plans and Specifications and Supervision of Work and Acceptance of Complete Work.—For the preparation of construction plans and specifications, advising on the award of construction contracts, for the supervision of construction, for the testing and acceptance of machinery or construction works, the remuneration shall be proportionate to the cost of the undertaking. Fees shall be in the first place based upon the estimate cost of the project, and in case of works proceed to construction the actual fees

shall be in accordance with the total cost of the undertaking. The following percentages shall represent the fees of a professional engineer and shall include remuneration for service of his office and overhead expenses:—

Preparation of Construction Plans and Specifications.—For the preparation of construction drawings and specifications necessary for the receipt of tenders, the fees of the engineer shall be 3 per cent of the cost of the works, provided the estimate is for an undertaking of $50,000 or less, with a minimum remuneration of $300 for enterprises of a cost of $10,000 or less. The undertaking to cost over $60,000 and less than one million dollars, the fee shall be 2½ per cent of the cost, and for all expenditure over one million dollars, the fee shall be 2½ per cent on the first million dollars and 2 per cent for all expenditure in excess of one million dollars.

Supervision of Construction. Testing and Acceptance of Construction Work and Machinery.—Partial Supervision.—Partial supervision comprising consultation at the engineer's office and occasional visits to the works during the normal duration of construction shall be remunerated at the rate of 3 per cent to 2 per cent of the cost of the undertaking, depending on the importance of the works. The remuneration of the engineer shall be 3 per cent of the cost of the works, provided the estimate is for an undertaking of $50,000 or less, with a minimum remuneration of $300 for enterprises of a cost of $10,000 or less. For undertakings to cost over $50,000 and less than $500,000, the fees of the engineer shall be 2½ per cent of the cost, and for all expenditure of over $500,000 the fee shall be 2 per cent of the cost.

Complete Supervision. — Complete supervision, comprising consultations at the engineer's office, visits to the works, and in addition, the necessary representative of the engineer on the works, the testing of supplies and machinery and the acceptance of machinery or works, shall be remunerated at the rate of 7 per cent to 3½ per cent of the cost of the works, depending upon the importance of same. A remuneration of 3½ per cent shall apply to undertakings of more than one million dollars, 4 per cent for works costing between $500,000 and $1,000,000, 5 per cent for works costing between $200,000 and $500,000, 6 per cent for works costing between $50,000 and $200,000, and 7 per cent for works costing $50,000 or less. The minimum of remuneration for complete supervision shall be $700 for works of $10,000 or less.

General Conditions.—A day's work of a professional engineer shall be computed as six hours. Nevertheless, when an engineer is obliged to go out of the city where his office is situated, his fees, when working on the per diem basis, shall be computed for each calendar day at the rate fixed, and each 24 hours or fraction thereof shall be considered as a whole day without taking into consideration the time actually spent on the work each day.

The fees of a professional engineer in case of questions in litigation are not contingent on the decisions of the court of justice, and shall be settled by the client immediately after the enquete.

For reports, studies, plans and specifications, the client shall pay one-half of the fees of the engineer at the time the engineer will inform him that the preliminary studies have been terminated, and the other half shall be payable upon the delivery of the report of the plans and specifications.

All test borings, assays or analyses necessary for the complete examination of any site or foundations for the erection of any structure shall be paid for by the client in addition to any other fees or percentages.

If the client desires changes in accepted specifications or plans, the engineers shall be entitled to remuneration based upon the necessary delay and time required to alter such plans and specifications to be based upon the per diem rates hereinbefore mentioned.

In the preparation of specifications and plans or during the supervision of construction, particular problem may arise which may necessitate calling a specialist into consultation. In such case the fees of the specialist, whose engagement must be authorized by the client, shall be directly paid by the client in addition to the fees of the engineer.

The actual cost of all travelling expenses and other disbursements in-

curred by the engineer in connection with the supervision of works, except the salaries, travelling expenses and living expenses of his staff to and from and on the works, shall be paid monthly by the client in addition to the percentage mentioned above in paragraph 3.

The percentages named for remuneration in paragraph 3 for supervision during construction are intended to cover the services of the engineer and of his staff during the period ordinarily expected to be covered by such construction, and in the event of delays occurring in the construction, through no fault of the engineer, the engineer's remuneration shall be increased to compensate him for the extra time necessarily spent by him and his staff in supervision, on the basis of the per diem rates for personal services and staff mentioned above in paragraph 2.

During the construction period the monthly payments made by the client to the engineer shall not be less than $400 for works costing less than $10,000; $600 for those over $10,000 and less than $50,000; $1,000 for those between $75,000 and $100,000, and $1,500 for works costing between $150,000 and $500,000, and proportionately for works costing over $500,000. The balance of any amount due for services during the construction period shall be paid by the client to the engineer on acceptance of the complete works by the engineer.

In case of bankruptcy or failure of a contractor on the construction work involving additional works on the part of the engineer over and above that contemplated in his original agreement, or in case any other work may be necessary and not directly relating to the preparation of specifications and plans and to the supervision of the work, the client shall reimburse the engineer and his staff on the per diem basis hereinabove mentioned provided in paragraph 2 for all such services.

All specifications and plans, and construction documents and data are the property of the engineer. The client is entitled to a copy of plans and specifications for record purposes only and he shall not use any of these for the construction of another project without remunerating the engineer therefor.

Connecticut to Spend $15,000,000 on Road Work

Close to $15,000,000 will be available during the next two years to carry on the work of the State Highway Department of Connecticut. This sum includes direct appropriations from the state and fees which the motor vehicle department receives from registrations, licenses and fines, in addition to the state tax on gasoline. The law requires that all fees from the motor vehicle department be used for the reconstruction and maintenance of trunk line highways.

The amount appropriated by the General Assembly for the highway department for the current 2-year fiscal period aggregates $4,200,000. The remaining $10,000,000, it is estimated, will be received through the motor vehicle department.

Heretofore, receipts from the gasoline tax have been turned into the state treasury direct by the motor vehicle department, but the recent session of the General Assembly, however, directed that this money be devoted exclusively to the betterment of the state's roads.

It is estimated that the gasoline tax will produce $2,000,000 in revenue during the next two years. The result will be that improvements and construction on the highways to that amount will be made possible, which Commissioner John A. Macdonald pointed out, will be of direct benefit to the motorist who pays the tax. It is inevitable that highway improvements mean a longer life for the cars traversing them, and, rather than proving an unfair burden, the tax on gasoline has been found to be a sound investment for the automobile owner.

For the fiscal two-year period ended June 30, the highway department received $7,600,000 in fees from the motor vehicle department, which was exclusive of the gasoline tax receipts. Based on income for the first two months of the present fiscal year, it is considered likely that this source of revenue will produce nearer $9,000,000 for the 1923-25 period.

This, combined with an estimated receipt of $2,000,000 from the gasoline tax, and the department's direct appropriation of $4,200,000, will aggregate close to $15,000,000. This will be the largest sum ever made available during two years for highway improvements in Connecticut.

Erecting Steel Highway Bridge 70 Miles from Railroad

Difficulties Encountered in Building Structure in Remote Section of Utah Described in Utah Highways

By JEAN R. DRIGGS,
President, Utah State Road Commission

The Hanksville bridge, spanning the Fremont River, at the eastern extremity of the state road in Wayne county, Utah, is at such a distance from the usual routes of through travel that there are probably very few people in the state acquainted with the country this structure serves and with the significance of this portal of the desert.

The transportation problems of Wayne county are both difficult and unique. As an example, the purpose of the bridge is not, primarily, to serve the needs of vehicular traffic, but to facilitate the movement of sheep and cattle to ranges and markets.

Getting Materials to the Bridge Site.—The Hanksville bridge is a through riveted truss, with a span of 120 ft. and a roadway 12 ft. wide, designed for a ten-ton truck. The abutments are of the tubular steel type 45 in. in diameter, extending 26 ft. into the shale foundations. The bridge has a clearance of 23 ft. above normal water level. There are timber trestle approaches approximately 50 ft. long on each end of the steel span, thus affording a waterway more than 200 ft. wide to take care of the flow during the later summer floods.

Due to the remoteness of the site it was planned to use local material so far as possible and authority was given me to select and purchase this at the most convenient points, the state to deliver all materials f. o. b. the bridge site.

As a result all the sawmill operators of the Thousand Lake and Boulder mountain districts were given an opportunity to supply timbers according to specifications. The timber furnished by these operators was a good quality of red pine, better than the commercial grades of common dimension timber and at a cost, laid down at Torrey, of $24 per thousand. Torrey is approximately the same distance from the bridge site as Green River, so the purchase of local timber was a distinct saving to the county.

The local saw mills did not furnish sufficient first-class timber for framing, so it was necessary to go into the Henry mountains and select round timbers for the trestle bents and floor stringers. This timber was obtained during December with the snow several feet deep in the Saw Mill basin and it was with considerable luck and concerted action that this timber was brought down before the mountains became completely blocked with snow. The timbermen worked from daybreak until after dark working to get this material out ahead of the impending snowstorm.

Telegrams and Construction Crew Arrive Together.—On one of the trips down from the mountains word was received—a telegram four days enroute—that the contractor was due that day with his entire crew and sure enough in they came as per schedule. Barely sufficient time was allowed to get them started on the foundations and falsework when another telegram arrived, also four days old, stating that the steel was in Green River awaiting inspection and unloading. Telegrams could be relayed by telephone to Torrey, but three days were required, with the winter mail schedule, to get it over the road from there to Hanksville, with the most favorable connections. A letter from Salt Lake was usually about eight days enroute.

Upon receipt of this telegram I started at once for Green River, making the trip in a day and a half on horseback and the steel was checked and unloaded.

The county commissioners had arranged to start teams to haul the steel from Green River, but after a delay of several days an exchange of telegrams disclosed the fact that the freighters had not yet started. The same day, Dec. 23, another telegram reached me at Green River, an urgent personal message for one of the steel men at Hanksville. There was no way of its reaching him in less than four days except by messenger directly across the desert. At 9 o'clock at night I found a driver and auto and started for Hanksville on what proved to be a remarkably wild ride across the desert. Midnight found us on the river opposite Hanksville

where we left the car and crossed on the foot bridge which had been erected at the bridge site and the message was delivered.

The non-arrival of steel had considerably dampened the spirits of the bridge crew, they were expressive in their impatience at the delay and were anxious to get through and go home. The people of Hanksville also found dissatisfaction in their allotment of freight.

Hanksville Invades Green River.—It is the custom of the county commissioners to divide the road work among the various settlements along the route and Hanksville had just been advised of its quota of haul on the steel. It appeared, however, that the commissioners had not been advised the full tonnage to be hauled, and not only that but had planned to make several trips, so to expedite matters I gave permission to the people of Hanksville to haul all the steel they could and haul it at once. The teams were on the road without delay and Green River must have been surprised to see 15 freight outfits come driving in from Hanksville, a village of 20 families; a go-after-it and get-it spirit that might be emulated by larger towns. They loaded up and were ready to start back two days after Christmas. As it happened there was just enough freight left to load up the outfits from the upper end of the county and all the steel went across in one trip instead of three.

As we were then able to complete the falsework and put the trusses in place before zero weather and the resulting ice jams in the river, the bridge was completed approximately 30 days earlier than would have been the case if the original plans of freighting the steel had been executed. The men who were cut short in the freight were given additional work at the bridge, hauling sand and gravel, to give them compensation for loss on the extra trips for steel.

Method of Construction.—Extreme precaution had to be resorted to in the construction of the false work for this bridge. The river bottom consisted of quicksand so treacherous at this point that neither horse nor man was able to ford the stream. Three piers, the center one being 20 ft. square, were constructed of logs from the drift wood washed down during the floods. A solid floor of these logs was first laid for a base but the sand was so yielding that as the cribbing was added they settled into the river bottom to a depth of 7 ft. The piers were connected with log stringers, the whole affording a substantial base for the usual falsework.

Almost as soon as the cribbing was above the water level the weather turned cold and continued until the temperature was 22 degrees below zero. During this time the river would freeze over at night and in the day time the water would flow over the top of the ice to freeze at night again. The water was so laden with quicksand that a layer of sand would form between each layer of ice until the level of the river had risen about 8 to 10 ft. and all our bottom falsework and stringers were buried.

A sudden break in the weather caused the ice to melt so suddenly that a part of the falsework was carried out in the night. However, the danger had been anticipated and the steel crew had the truss held in place with erection bolts.

Through the spirit of co-operation shown by the people throughout the county in getting out timber and hauling supplies the bridge was completed within the contract time and under the estimated cost. The obtaining and hauling of timber from the mountains during the winter months, the hauling of steel and other material across the 70 mile desert and the erection of the structure were all accomplished without a single accident.

Cost of Connecticut Highways, 1914 and 1923

According to a statement of the State Highway Department of Connecticut, the average cost of road construction in that state has increased approximately 150 per cent in the last 10 years. The costs of the various types of highway have all greatly increased, as the following table will show:

	Per Mile 1914	Per Mile 1923
Gravel	$ 8,000	$20,000
Macadam	12,000	25,000
Bituminous macadam	14,000	30,000
Concrete	17,000	40,000
Bituminous concrete	18,000	45,000

During the last 10 years the highway department has constructed a total of 873.17 miles of roadway, of which 521.25 were new construction and 351.90 were reconstruction.

Past, Present and Future of Engineering

Extracts From Inaugural Address Before Toronto Branch of Engineering Institute of Canada

By PROF. C. R. YOUNG

Early Status of the Engineer.—The modern professional engineer had an origin amongst the humble millwrights of England. Upon these skilled workers the responsibility for constructional enterprises devolved prior to the days when something like a profession of engineering came into being. Brindlay, whose notable achievements ushered in a new era in material development in the British Isles, was scarcely able to read or write. He taught himself these arts when he was employed as an apprentice, and was never able to spell correctly or to write better than a half-intelligible letter or report. Books were practically a closed world to him and he lived and died essentially in the world of mechanics. Both Watt and Smeaton were mathematical instrument makers, and by reason of their superior education were able to transcend Brindley in the breadth of their professional achievements. Telford began his constructional career as a stone mason and John Rennie entered upon his life work through the obscure portal of the millwright.

It was to be expected that coming from such lowly origins the engineer would be poorly paid. Brindley, through all his long and exacting employment with the Duke of Bridgewater, did not receive at any time more than 84 ct. a day, and most of the time his compensation did not exceed 60 ct. These were days when the engineer must of necessity remain in a low rank of society, and when his scale of living must be adjusted thereto. Thus we find that Brindley, in a fit of disappointment over his troubles with an engine, records in his diary the illuminating entry "run about a drinking 30 ct." Even Smeaton, whose intellectual gifts and attainments made him an honored member of the Royal Society, did not receive at any time more than $10 a day for his professional services.

It was to be expected that the attitude of cultured and polite circles and of literary men generally would scarcely be cordial to the engineer. Thus, Shakespeare speaks of "mechanic slaves with greasy aprons, rules and hammers," and Dr. Samuel Johnson defined mechanical as "mean, servile." Although Johnson was the most active literary man of his time and expressed opinions on almost every conceivable subject, he did not once comment on the splendid works of Brindley, although they were all completed in Johnson's day. Andrew Meikle, inventor of the threshing machine, a piece of mechanism that has revolutionized agricultural industry, was not even mentioned in Scottish biographies of the time. Smeaton was severely criticised by his friends of the Royal Society for undertaking the navy work of making a road across the valley of the Trent.

Growth of Confidence in the Engineer.—With the splendid achievements of the pioneers in modern engineering, it gradually came to be appreciated that there was advantage in securing the services of skilled technical men. It was seen that mishaps of a serious character often came about when the work was entrusted to unskilled persons, and that generally such were avoided when trained men were employed. A notable and classical instance of this was the collapse of St. Chad's Church after it had been condemned by Telford, much to the disgust of the church authorities, who turned it over for repair to an incompetent and unskilled person who represented that there was very little at fault with the structure.

It was not long before it was seen that the forecasts of the leaders in engineering were generally sound and that proceeding against the advice of trained and ingenious engineers was unprofitable. James Nasmyth recounts the extraordinary and futile efforts which he made to convince the British Admiralty of the virtue of his steam hammer. Meeting only passivity, he proceeded to instal his hammers in the furnaces and principal foundries of England and sent them abroad to foreign countries, even to Russia. At last, after three years, the admiralty finally awoke to the fact that a device known as the steam

hammer was already in successful operation and that perhaps they should inquire into the matter. On investigation they found that Nasmyth had been telling the truth. John Rennie records a similar experience with the Navy Board in attempting to convince that body of the desirability of steam propulsion for ships of war. His attitude to the official density of this body may be gathered from his comment that "of all the ignorant, obstinate and stupid boards under the crown, the Navy Board is the worst. I am so disgusted with them that could I at the present moment with decency relinquish the works under them which I have in hand I would do so at once." Later, the soundness of Rennie's views was conceded.

It was soon found that while formerly those who imperilled their fortunes in engineering enterprises in the hope of gain were proceding upon a perilous adventure, there was now a high probability of profiting by following the advice of skilled engineers. Those who had formerly been known as "adventurers" now became known as "inventors." The respect to which engineers gradually attained through the successful carrying out of great works is well indicated by the attitude of that distinguished British administrator, Lord Cromer, when speaking of the work carried out in Egypt by British engineers. Said he, "The British engineer, in fact, unconsciously accomplished a feat, which, in the eyes of a politician, is perhaps even more remarkable than that of controlling the refractory waters of the Nile. He justified Western methods to Eastern minds."

High Integrity of Engineers.—Increased confidence in the engineer arose through repeated demonstrations of high integrity in the professional careers of the great leaders. George Stephenson, in recommending a type of rail for the Stockton and Darlington Railway, definitely specified a rail other than the cast iron one on which he held a patent, although he might have profited to the extent of a very considerable sum had he cared to use his own rail. When Sir Benjamin Baker was appointed consulting engineer on the Asyut barrage, he found that unforeseen conditions made it necessary to alter very materially the design of the structure. No prices having been named in the original contract for much of the new work involved, Baker told Lord Cromer that the contract ought in fairness to be cancelled, and, at the same time in the interests of Egypt an arrangement entered into by which the work would be hastened to completion at the earliest possible moment, leaving the question of contractor's profit to him. Without any hesitation, Sir John Aird, the contractor, agreed to leave the matter entirely in Baker's hands, proceeded vigorously with the work and finished it a year ahead of time, with a gain to the country due to the extra year's supply of water of $3,000,000. Thus did high integrity on both sides enrmously enhance the reputation o f both engineer and contractor and greatly benefit the client of both.

Thomas Telford, when appointed engineer of the Ellesmere canal, was well aware of the fact that he had not that extended experience in earthwork, however skilled he might be in masonry, which he ought to have to undertake such an important enterprise without support. He consequently retained William Jessop to advise him in this regard. Some engineers would have attempted the work entirely on their own responsibility.

Alfred Noble was characterized by J. Waldo Smith as the most conscientious engineer that he had ever known. Noble never rendered a snap judgment, even on matters of small importance. He was more anxious to be correct than to appear brilliant. Any advice given or judgment pronounced was always the result of the most careful consideration. He repeatedly refused lucrative engagements for the sole reason that he felt he could not give them the study and attention which they demanded. Compared with this attitude the practice of some immature and irresponsible engineers in undertaking work for which they are not sufficiently experienced is as playing the market with trust funds.

Influence of Engineering Societies.—Much of the high prestige now appertaining to the engineer has come through the steady and strong upward guidance of the great engineering societies. The first of these was the Society of Civil Engineers (now known as the Smeatonian Society of Civil Engineers) founded in 1771. It was, however, an exclusive organization composed of the most notable engineers of the time. Initially, it con-

sisted of only seven members and at the end of 21 years of only 65.

Believing that a more comprehensive organization would do much in training and guiding the younger engineers, certain leaders of the profession brought about the foundation in 1818 of that fine organization, The Institution of Civil Engineers of Great Britain. This came upon the profession at a time when there was tremendous activity in the constructional world. It was launched at an opportune moment and exerted a tremendous influence in shaping the young engineers of the time, and in developing standards of professional practice.

In Canada a parallel work has been done by the Engineering Institute. Although founded as the Canadian Society of Civil Engineers as late as 1887, it has in its 36 years attained a membership as great as that which it took the Institution of Civil Engineers 70 years to reach.

Profession Versus Business.—There is perhaps no question more frequently asked than the time-worn one as to whether engineering is really a profession or not. It has been the ideal of many leading engineers to place engineering on a purely professional basis and to divest it of the characteristics of a business which it has taken on in recent years. One must frankly admit that the results achieved have not been gratifying and that engineering is, if anything, farther from the status of a pure profession than it was a generation ago.

If one were asked to define the essentials of a profession, one might say that properly the professional man should make his services available to such clients as care to consult him, and generally for stipulated fees rather than for a salary. Relations with the client should be on the highest possible ethical basis and no measures should be adopted for the securing of commissions which would not be acceptable in type to those prevailing in the professions of law and medicine. One might enumerate as some specific essentials of an engineering profession, the possession of skill and learning by the practitioner, the maintenance of high ethical relations with the client, and the observance of altruistic motives in his relations with the public.

So basic is the idea of learning in a true profession that one often hears mention of the "learned professions." It is inadmissible for the engineering practitioner to be an ignorant or unlettered man. Although the proprietor of a barber shop or of a shoe shining stand may be operating for the benefit of such customers as may care to patronize him, and for a fixed fee, it cannot be maintained that these callings are in the category of professions, in spite of the recent effort to incorporate barbering in British Columbia as a skilled profession. But on the basis of learning as a requisite, however, one might very properly include in the ranks of the "learned professions," the work of the skilled accountant or auditor, who in his field maintains towards clients relations that are comparable with those maintained by the professional engineer.

Attitude of Early Engineers Toward Their Clients.—A basic essential of professional life is that the relations of the professional man to his client should be those of the most exalted trust and of the most circumspect solicitude for the interests of his employer. Telford, for example, while acting as an engineer for several canal companies declined an appointment as engineer to the Liverpool and Manchester Railway on the ground that it would prejudicially effect the interests of his existing employers. Sir John Fowler was preeminently a shareholder's engineer. He restrained his natural impulse to create great and enduring works for monumental purposes and made sure that the interests of the persons who were furnishing the money were primarily observed. The public very properly expects of a professional man a high attitude with regard to public obligations. It expects him not only to further the interests of the people at large, but to prepare himself for the better performance of such service. The appropriate attitude to his profession might very well be put in the words of Francis Bacon "I hold every man a debtor to his profession; from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavor themselves by way of amends to be a help and ornament thereto."

Smeaton's attitude in this regard

would have fully satisfied Bacon. He held that "the abilities of the individual were a debt due to the common stock of public well-being." Having this in mind, he limited his professional employment so that he might devote a certain portion of his time to self improvement and scientific investigation. He systematically resisted tempting offers to attract him from this settled course.

Present Status: Part Profession; Part Business.—One must admit that the present status of engineering is that of part profession and part business. The methods of solicitation of new work in engineering are by no means in conformity with those observed by the leaders in the professions of law and medicine. Intensive canvassing and lobbying which characterize the conduct of some engineers in the consulting field at the present time do not well comport with the high ethics of Smeaton and Telford. They are of one and the same type as the methods employed to secure orders for bacon or boots.

The competition that is sometimes introduced by engineers with others who have to all intents and purposes secured a given piece of work, is not that characteristic of a pure profession. Thus, when the plans of an engineer have been accepted and tenders are called thereupon, it may be questioned as to whether alternative designs are properly tolerable without the full prior knowledge and consent of the client's engineer. It is, of course, a common procedure for engineering contractors to submit their own designs in competition with those of the engineer in charge of the work, and the practice is so firmly established that it is not likely to be given up. In essence it is an embarrassing procedure. It in effect proclaims that the client's engineer has insufficiently studied the situation and that he has overlooked the merits of another scheme which might prove cheaper than the one which he recommended. Anything which lessens the confidence of the client in his engineer's complete mastery of the subject may well be considered as questionable ethically, but so far have we proceeded from pure ethics in the practice of engineering that this procedure often excites no comment. Under such conditions it becomes very difficult to frame a comprehensive code of ethics for engineers. When they are operating in part as professional men and in part as men of business it does not seem practicable to establish a purely professional code of ethics that will procure uniform observance by the engineers of the country.

Future of Engineering.—We are, therefore, constrained to ask whence is the engineer bound and what is the future of engineering? One may find in the public statements of leaders of the profession for many years back expressions of doubt as to whether society could absorb all of the engineers who were offering their services. Thus, James Walker, one of the early presidents of the Institution of Civil Engineers said in his presidential address in 1841, as follows:

"While I congratulate the Institution on the increase of its members, I ought at the same time to express my opinion that, from the number of young gentlemen who within the last ten years have studied for, or have entered, the profession, the supply is likely to be at the least equal to the demand, and to caution those who intend entering, or are now studying for it, against confining themselves to the strictly professional part of the usual routine of education. The railways, both during the preliminary surveys and in their subsequent construction and management, in addition to other works of engineering, have given employment to many. But the principal towns are already connected by railways, or engineers and surveyors are now employed in projecting or executing lines where they are yet wanted. Is then the demand for professional gentlemen likely to increase? Is it not likely rather to decrease?"

At that time the total membership of the Institution was 475.

There had arisen in the early days of railways in England a phenomenal demand for the services of men with any experience in engineering or surveying. Surveyors and levellers were paid as much as from $36 to $75 a day, although many were highly incompetent and had secured what knowledge they knew of the subject from very brief courses of instruction. It is recounted that a peddler of stationery earned $25 a day and his expenses as an assistant surveyor. A fat and wheezy fellow, long unaccustomed to work, received $15 a day for work on surveys, and could have had

$25 had he been willing to attempt the hills in a bold piece of country. He preferred $15 and a level line.

The questions that were raised in the days of James Walker with respect to the absorptive power of Great Britain for engineers might well be raised in Canada at the present moment. There are in this country approximately 12,000 engineers in all grades and departments. At the same time there are in attendance in Canadian engineering colleges about 2,100 students, or about one-sixth as many as all the engineers in the country. One may well ask if employment on strictly engineering work is to be found for such a large output. In the United States the situation is still more striking, for although the population of that country is only about fourteen times greater than that of Canada, there are about 50,000 engineering students in the engineering colleges.

Change in the character of employment will constitute the solution of the problem. Whereas 15 to 20 years ago, construction of railways at a terrific rate afforded employment for large numbers of young engineers, that source has largely dried up and railway employment has to do principally with maintenance and operation. Any group of engineers relying wholly on original construction for employment may be embarrassed during periods of hard times. With a commercial depression, the first thing that is done is to curtail construction and extensions. If, however, the engineer is trained and experienced in problems of operation and management, he may easily pass into executive and administrative positions with perhaps financial advantage to himself. One interesting source of employment of this character now opening up is city managerships. There are in America over three hundred cities and towns governed in this manner and of the managers in charge a substantial portion are trained engineers.

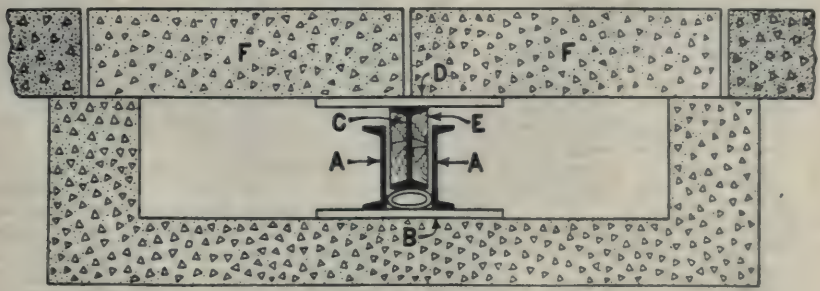
Education for Broadening Employment Field of Engineer.—So frequent have been the instances of graduate engineers undertaking work involving a combination of engineering and business that engineering colleges in America have for some years past been undertaking to prepare men for this combined field. Harvard University offers a 5-year course in business administration and engineering combined, options being granted in accordance with the department of engineering elected by the student. Yale offers a 4-year course in administrative engineering devised for students who expect to fill executive positions in which a knowledge of engineering is required equivalent to that ordinarily gained in any one of the regular courses. The University of Kansas offers a course in Engineering and administrative science with two technical options. Pennsylvania State College has regular graduating courses in industrial engineering. New York University has established a 4-year course in business and engineering. The University of North Dakota has a 4-year course in general industrial engineering with 60 per cent of the time devoted to fundamental subjects in science, mathematics and technical engineering and 40 per cent in subjects pertaining to business management, administration and allied topics. Union College offers a combined 4-year course in which business and cultural subjects form 35 per cent of the total. The Universities of Illinois, Wisconsin, Ohio and Cincinnati maintain co-operative courses in which engineering is combined with economics in the schools of commerce. Although no special department in administrative engineering has so far been established in the University of Toronto, the inclusion of many business subjects in the curriculum has been brought about in recent years. Graduates in every department now have a useful general conception of the commercial field and are deriving therefrom the advantage of increased employability.

Thus, there is undoubtedly a strong trend towards the broadening of employment of the engineer. If it be conceded that a departure from strictly technical lines is legitimate, an immense new field of activity opens out for the young man with a combined training. Experience is showing that a larger and larger proportion of engineering graduates are taking positions in which a combination of business and technology is desirable, and without doubt the time is coming when the technically trained man will make his influence as strongly felt in business as in the specialized fields of engineering enterprise .

Automatic Scale and Highway Traffic Counter

Apparatus developed and constructed by the U. S. Bureau of Public Roads for automatically counting the traffic on a highway is described in a recent bulletin of the National Research Council. The apparatus consists essentially of a steel trough 10 ft. long, containing a piece of fire hose 9 ft. long by 2 in. in diameter, on which rests a plunger attached to a platform, over which traffic passes. As shown by the sectional drawing, the trough is made of two 6 in. channels (A) connected to a base ¾ in. by 14 in. plate (B), and the plunger consists of a 6 in. I-beam (C) attached to a ¾ in. by 14 in. plate (D). Wooden guides (E) bolted to the I-beam prevent horizontal movement of the plunger. The trough is set in a concrete box so that the top of the platform is approximately flush with the bottom of the road surface. Traffic passes over concrete slabs (F), which rest on the plunger. The hose, filled with heavy oil, is sealed at one end, while at the other it is connected to a recording device* by means of a flexible tube. A record of pressures

Automatic Scale and Traffic Counter Installed at Arlington Experimental Farm.



Arrangement of Traffic Counter in a Road.

*In this instrument the recording device is a trainagraph manufactured by the American Steam Gage and Valve Manufacturing Co., Boston, Mass.

exerted on the oil in the hose is thus secured. The recording paper is automatically moved forward a short distance every time a pressure is recorded. The weights of the front and rear wheels, as well as the number of vehicles passing, are recorded. The passage of 4,800 traffic units can be recorded on one roll of paper. Before being used on a road, the apparatus is calibrated with static loads.

The apparatus is installed in the Washington-Baltimore boulevard for traffic counts.

Traffic Accidents on British Highways

During the period Jan. 1 to Aug. 31, 1922, the engineers of the roads department of the Ministry of Transport of Great Britain investigated 94 road accidents, involving deaths or injuries. The causes of these accidents may be roughly classified under the three following headings: (a) Negligence or incompetence on the part of the driver or drivers; (b) mechanical defects in the vehicles or unsatisfactory road conditions; (c) error or negligence on the part of other persons. It will, of course, be understood that more than one of these causes may be contributory to any particular accident, and any such classification can only be approximate. The results of the inquiries are summarized in Table I.

Table I

Cause of Accident	No. of Accidents	No. Killed	No. Injured
(a) Negligent driving	55	35	90
Faulty judgment	6	17	5
Inexperienced driver	1	1	....
(b) Insufficient lighting	1	....	2
Faulty steering gear	5	2	12
Burst tire	1	1	4
Mechanical defect	1	....	1
Faulty brakes	4	4	9
Back axle failure	1	....	2
Changing gear on steam roller going down gradient	1	....	2
Skidding	4	2	1
(c) Pedestrian at fault	5	5	5
Pedal cyclist at fault	1	....	1
Alighting from moving bus	1	....	1
Horse unattended took fright	2	1	2
(d) Unknown	5	7	2
Total	94	75	139

It will be noticed that the number of accidents due mainly to negligence or incompetence on the part of the drivers form almost exactly two-thirds of the total.

Method of Grouting Foundation for Highway Bridge

Construction work is now well advanced on a bridge over the Yadkin River on Route 10 of the State Highway System of North Carolina. The bridge will consist of seven reinforced concrete arches, each 150 ft. span, and two 40-ft. deck girder approach spans. The plans call for foundations for all piers to be carried from 2 to 3 ft. into solid rock. Investigations for pier No. 2 showed an open seam of from 9 in. to 15 in. at a depth of 12 ft. below original rock surface.

This condition was considered unsafe for the load of the pier and additional test holes were drilled into the foundation to determine whether the seam extended throughout the entire footing area. This was found to be the case and an extra work order was secured to cover the expense of washing out the seam and grouting same, the estimated cots being $250.

How this work was handled is described in the North Carolina Highway Bulletin.

A unit price was obtained from the contractor for drilling additional holes to the seam, a total of eight holes, or two rows of four holes, each being put down. Excavation for the footing had advanced to such a stage that it was decided to pour the footing, washing out and grouting the seams afterwards. An 8-ft. length of 2 in. pipe was placed in each of the eight holes the footing then poured to an average depth of 4 ft., this leaving about 4 ft. of each 2 in. pipe extending above top of same. Work was then begun of washing out the seam through the eight holes or pipe. A 2 in. line was brought direct from the pump to one of the eight pipes and a pressure as high as 65 lb. maintained while the work progressed. Water would rise and flow from any one of the remaining seven holes, bringing mud with it and also small pieces of decayed granite. This was continued until water flowing through any hole was clear and resulted after four hours steady pumping. At any time, with water entering a corner hole, it would run with considerable force from any one of the other seven holes which were left open, occasionally forcing ahead of it a solid stream of mud or decayed material.

At the time when grouting was commenced it was not known whether pressure would have to be applied to fill the entire seam or not, but arrangements were made to this effect. A 3 in. pipe about 10 ft. long was placed on top of the 2 in. pipe above one of the eight holes, a funnel being placed on top of this to receive the grout. This gave a head of grout of 26 ft. on top of the seam and proved sufficient to fill all the holes. About 2 cu. yd. of grout were used and within two hours from the time when grouting was commenced it appeared in each of the seven open holes which was an indication that the entire seven had been filled, giving the top layer of rock solid bearing on that underneath. The actual cost of the operation was $237.65.

Method of Resurfacing Old Concrete Pavements with Brick

Two recent jobs of resurfacing worn pavements with vitrified paving brick and asphalt filler are described in the July issue of Dependable Highways. One of these jobs was on a city street in Bettendorf, Ia., the other was a country highway extending between Ghent and Akron, O. The last mentioned work is described as follows by H. G. Sours, resident engineer of Ohio State Highway Department:

Resurfacing Ohio Highway.—The old concrete pavement was built in 1912, was 14 ft. wide and 6 in. thick. The mix was 1:2:4 and the coarse aggregate was gravel; in some places slag was used and in others bank-run gravel. The old pavement had been broken in many places during the last few years and been repaired with 1:2:4 concrete 8 in. deep in patches varying from 2 sq. yd. to 75 sq. yd.

The reconstruction consisted in building curbs, repairing base, widening and elevating curbs, and paving with brick on a granulated slag bed. The curbs were 18 in. wide and 12 in. deep and conform as nearly as possible to the original grade. These curbs were built against the old pavement, to make the new pavement 17 ft. wide. The excavation for the curbs was done with a tractor and plow, and bladed out with a small blade grader, then fine graded by hand.

Wooden forms of 2x6 in. material were staked to line and grade and held in place by twisted wire and wooden spreaders. Following the curb building a small mixer repaired all the holes in the old pavement with new concrete. All the old concrete which was shattered or badly cracked was removed back to solid material and replaced. The old broken material was placed on the shoulders outside the curb.

Slag Used for Bedding Course.—Granulated slag bedding was then spread and rolled thoroughly with a 6-ton tandem roller. The compacted bedding course varies in thickness from 2 in. to 4 in., all uneven places in the old pavement being taken out with granulated slag. A small amount of screened granulated slag was then dragged over the base with a template and rolled with an ordinary hand roller to make a finished bedding course. The brick were then dropped, rolled and filled with asphalt filler. The roadway is now being shouldered and the ditches trimmed and sloped.

Some of the granulated slag was rolled in place last fall and not covered with brick. When this was removed this spring it had to be done with picks, and was of about the same hardness as dense sandstone.

Resurfacing in Bettendorf, Ia.—The resurfacing in Bettendorf, Ia., was on a street carrying double car tracks. When these tracks were relaid several years ago they were put down at a grade which would permit the resurfacing with brick inasmuch as the pavement had been in bad condition for the last seven years, according to City Engineer N. H. Tunnicliff.

The street is a part of the main artery out of Davenport, leading northward along the west bank of the Mississippi River. It is about 50 ft. wide, the roadway on each side of the tracks measuring about 18 ft.

City Engineer Tunnicliff specified a 3-in. vertical fibre, plain wire-cut brick, asphalt filled by the squeegee method. The brick were laid on a 1:4 cement-sand bed, of at least 1 in. in depth, after new concrete had been used to fill all major depressions and holes in the old concrete pavement. The contract was let at $2.42 per square yard, plus $10 per cubic yard for extra material used in filling cracks and holes.

Testing Materials for Concrete Pavements

Methods Summarized in Report Presented at International Road Congress, Seville, Spain

By DUFF ABRAMS,
Professor in Charge, Structural Materials Laboratory, Lewis Institute

Materials used in cement concrete pavements in the United States are as follows: (1) Portland cement, (2) aggregates, (3) water, and (4) reinforcing wire or bars.

Tests of concrete materials are made for two distinct purposes: (a) To establish underlying principles, and (b) to determine whether a given sample conforms to certain predetermined standards. The two purposes in testing mark the distinction between research and inspection. The adequacy of the tests made in inspecting concrete materials is dependent upon the correctness of the principles established by research. In the following discussions only the standard tests for quality of materials will be included.

The American Society for Testing Materials has been engaged for many years in collecting data and preparing standard specifications and tests for all types of road materials. The society is made up of representatives of both producers and users of materials. The tests of this society are generally recognized as authoritative.

Tests of Portland Cement.—Portland cement is the product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum. Clinkering is produced in a rotary kiln at temperatures of about 1500° C.

The following tests are made on portland cement:

Fineness—Using a sieve having 200 meshes per linear inch (79 per in.).

Soundness—Neat cement pat placed for 5 hours over boiling water 24 hours after mixing, must remain firm and hard and show no signs of distorting, cracking, checking or disintegrating.

Time of Setting—Vicat needle, initial set over 45 minutes, final set less than 10 hours. Gillmore needle, initial set over 1 hour, final less than 10 hours.

Tensile Strength—Briquets of 1 sq. in. cross-section of 1:3 standard sand mortar, by weight, must give a strength of 200 lb. or over at 7 days, and 300 lb. or over at 28 days, when stored 1 day in moist air and remainder in water.

Chemical Analysis—is only infrequently carried out.

General Requirements for Aggregate.—Aggregate is defined as "Inert material which is mixed with portland cement and water to produce concrete; in general, aggregate consists of sand, pebbles, gravel, crushed stones, blast-furnace slag, or similar materials."

Aggregate for concrete pavements must be clean, structurally sound and inert in the presence of cement and water; it must possess also a certain quality which may term weather-resistance. The separation of aggregate into fine and coarse is generally required since it facilitates securing uniformity in the grading of successive batches. A wide variety in size and grading may be used with good results.

Tests of aggregates have been undergoing marked changes during the past few years. The earliest tests of coarse aggregate were adapted directly from those made on rocks for macadam roads. Experience has shown that the tests for hardness, toughness, and cementation values which were formerly made on crushed rocks for macadam road construction are of little use in judging the quality of an aggregate for concrete pavements.

Tests of Fine Aggregate.—Fine aggregates are generally subjected to the following tests:

Sieve Analysis—Use wire cloth sieves having 100, 50, 30, 16, 8 and 4 meshes per linear inch.

Organic Impurities in Sand—Digest sample in 3 per cent solution of sodium hydroxide and observe color after 24 hours.

Silt—Determine loss of weight of 500-gram sample, due to washing in shallow pan and rejecting wash water,

Mortar Strength—Tension tests of briquets or compression tests of 2 by 4-in. mortar cylinders at ages of 7 and 28 days, using 1:3 mix by weight or by volume. Make parallel tests on 1:3 standard sand mortar. There is a growing tendency to substitute compression tests of mortar for tension tests in both sands and cements.

Tests of Coarse Aggregate.—Coarse aggregates are generally subjected to the following tests:

Sieve Analysis—Use square-mesh wire-cloth sieves No. 4 (that is, 4 meshes per linear inch), ⅜ in., ¾ in., and 1½ in.

Abrasion—Determine per cent of water in Deval abrasion machine, using 50 pieces of crushed rock weighing 5,000 grams and run for 10,000 revolutions at 30 r.p.m. A number of modifications of this test have been introduced during the past few years, in an effort to make the test more applicable to the requirements of graded sizes of crushed rock or gravel.

Miscellaneous Tests of Aggregate.—In addition to the foregoing tests, which are more or less standard, the following tests are sometimes made on aggregates:

Unit Weight—Puddle a sample in a metal measure of cylindrical form with depth equal to diameter and of 1/10 to 1 cu. ft. capacity, using a small metal bar and filling the measure in three equal layers. The weight is reported in pounds per cubic foot.

Toughness of Gravel—The U. S. Bureau of Public Roads has recently introduced an impact test for gravel which is expected to reveal the presence of soft or friable particles. It is made by dropping a steel ball of known weight on a selected number of particles from the sample. The height of drop required to produce rupture is a measure of the toughness of the gravel.

Shale in Gravel—Separate shale by flotation process, using a solution of zinc sulphate.

Concrete Strength—In many instances the quality of both fine and coarse aggregate is determined by 28-day compression tests of 6 by 12 in. concrete cylinders of the mixture to be used on the work. In making concrete tests care must be used to procure a uniform consistency in the various mixtures. Concrete for these tests is generally mixed by hand.

Wear Tests of Concrete—Considerable experimental work has been done in laboratory studies of the wearing resistance of concrete. A number of different types of apparatus have been developed for this purpose.

Samples of Aggregates.—Laboratory tests of aggregate require about 25 lb. of fine aggregate and about 50 lb. of coarse aggregate. If concrete tests are to be made, larger samples will be necessary. Great care is necessary to secure representative samples.

Field Tests of Aggregates.—Many of the highway departments supply inspectors with apparatus for making approximate field tests for silt, organic impurities, sieve analysis, etc., as the aggregate is delivered on the work.

Relative Merits of Different Aggregates.—Many different types of aggregates may be used for concrete pavements. There is a growing recognition in the United States of the fact that the quality of the concrete is more important than the quality of the aggregate, and that with proper care in proportioning, mixing, placing and curing, concrete of high quality can be produced with inferior aggregate.

Water.—In general no special tests are made on the water used in mixing concrete. Specifications for concrete require that water shall be clean from and free from oil, alkali, organic matter or other deleterious substance. Only in rare instances is difficulty encountered in securing water of good quality.

Tests of Reinforcing Steel.—The following tests are made on reinforcing bars or wire: (a) Tensile strength, (b) elongation, (c) reduction in area, (d) chemical analysis.

Testing Laboratories.—There are approximately 100 laboratories in the United States which are equipped to carry out tests of cement, aggregates, etc. These may be classified as follows: (1) U. S. Government (bureau of public roads, bureau of standards, etc.); (2) state highway departments; (3) county and municipal; (4) universities and schools; (5) private testing laboratories; (6) railroads and miscellaneous.

The 1924 Road Show of American Road Builders' Association

About 230 Manufacturers Will Have Exhibits of Highway Equipment, Materials and Supplies

Unprecedented demands for space in the 1924 Road Show of the American Road Buliders' Association, to be held Jan. 14 to 18 in Chicago, greatly complicated allotments to applicants at the drawings on Nov. 1 and 2. Requests were filed for more than three and one-half times the main floor space available at the Coliseum. Applications for space in the Coliseum Annex, the ballroom and the Greer Building also were much in excess of the floor area.

The allotments were in charge of the executive committee, and Mr. C. M. Upham, convention and road show manager of the American Road Builders' Association, and of the executive committee of the Highway Industries Exhibitors' Association. The two executive committees were assisted by an advisory committee of six, each representing one of the six main classes of exhibitors. Working in close co-operation, these officials developed methods of reduction in space and choice of location based on several definite factors. These methods were then applied to all applications.

As a result of this very definite and thorough policy of determining the amount and the location of space allotted, it was possible to take care of all applicants whose requests for space were filed according to the requirements. Although the space allotted to most applicants was less than they desired, all will have a good chance to exhibit. In fact, nearly all exhibitors have as much or more space than they respectively occupied in the 1923 show. Due to the rearrangement of aisles and exhibit spaces, it was also possible to permit a considerable increase in the number of exhibitors.

Judged from the great care used by exhibitors in submitting their applications, it is evident that exhibits in the 1924 Road Show will be worked out most thoroughly. The character of the proposed exhibits also indicates that the 1924 Road Show will in every way surpass the remarkable success of the 1923 exhibition. About 230 of the leading manufacturers of equipment, materials and supplies used in building and maintaining highways evidently have come to recognize that the road builders of the country consider the road show the one big chance of the year to get up to date on all that is new in the industry.

The following is a list of those to whom space has been allotted. Various changes may be made in this list, but additions will be possible only in case applicants do not accept space allotted to them.

Galion Iron Works
Koehring Co.
Holt Manufacturing Co.
Blaw-Knox Co.
Wood Hydraulic Hoist & Body Co.
Kinney Manufacturing Co.
Shaw Enochs Tractor Co.
The White Co.
Thew Shovel Co.
Barber Greene Co.
General Motor Truck Co.
Equipment Corporation of America
Novo Engine Company
Fate-Root-Heath Company
Hvass Co.
Heil Co.
Erie Steam Shovel Co.
Russell Grader Mfg. Co.
C. H. & E. Manufacturing Co.
The Barret Co.
Burch Plow Works Co.
Sauerman Bros.
Monarch Tractor Co.
Beach Manufacturing Co.
Koppel, Ind., Car & Equipment Co.
American Casting Co.
Haiss Manufacturing Co.
Sterling Motor Truck Co.
Domestic Engine & Pump Co.
Climax Engine Co.
Geo. B. Whitcomb Co.
National Paving Brick Co.
Milwaukee Locomotive Mfg. Co.
Kelly-Derby Co.
American Cement Mfg. Co.
Jaeger Manufacturing Co.
Granite Paving Block Mfg. Association
Construction Machinery Co.
The Texas Company
The Western Wheeled Scraper Co.
Insley Manufacturing Corporation
Carford Motor Truck Co., Ind.
Bear Tractors, Inc.
Mash Capron Co.
Baker Manufacturing Co.
Smith Engineering Works
Austin Manufacturing Co.
Buda Company

L. P. Green Co.
Asphalt Association
W. & L. E. Gurley
Public Works Journal
Concrete Steel Company
Ingersoll-Rand Co.
Cleveland Tractor Co.
Davenport Locomotive Works
Byers Machinery Co.
Lakewood Engineering Co.
Austin Western Road Machinery Co.
T. L. Smith Co.
Foote Concrete Machinery Co.
The Hug Company
International Motor Co.
Pawling & Harnischfeger
Elgin Sales Corporation
J. D. Adams Co.
Chain Belt Co.
Austin Machinery Corporation
Bucyrus Company
Northwest Engineering Co.
Heltzel Steel Form & Iron Co.
Le Roi Company
The Osgood Co.
Oshkosh Manufacturing Co.
Portland Cement
Lee Trailer & Body Co.
Metal Form Corporation
Littleford Bros.
Link Belt Co.
National Highway Association
Avery Co.
Autocar Company
Dunn Wire Cut Lug Brick
A. B. French & Co.
Republic Motor Truck Co.
Philip Carey Co.
Warren Bros. Company
Erie Steel Construction Co.
Barber Asphalt Co.
Anthony & Co.
Engineering News Record
Schramm, Inc.
C. L. Best Tractor Co.
W. S. Tyler Co.
Hercules Corporation
F. P. Cummer & Son Co.
Clay Products Association
American Tar Products Co.
Erwin Greer
Stroud & Company
Parsons Company
Waukesha Motor Co.
East Iron Machinery Co.
Owen Bucket Co.
The American City
Manufacturers Record
Wiard Plow Company
Engineering and Contracting
Carbic Mfg. Company
American Production & Trading Co.
Barnes Manufacturing Company
Mead Morrison Mfg. Co.
Electric Wheel Co.
The Bates Machinery & Tractor Co.
Ransome Concrete Machinery Co.
Borg & Beck Company
Black & Decker Mfg. Co.
R. J. Lewis Mfg. Co.
Truscon Steel Co.
Universal Crane Co.
Huber Mfg. Co.
American-Vibrolithic Corp.
Graham Bros. Trucks
Chicago Motor Truck Mfg. Co., Inc.
O'Connell Motor Truck Co.
Archer Iron Works
Watson Truck Co.
Good Roads
Beaver Manufacturing Co.
Petroleum Motor Corp.
Turner & Moore Mfg. Co.
Pittsburg Testing Laboratory
W. B. Louer Co.
Full Crawler Co.
William-Heaver-Morgan Co.
Hercules Motor Co.
Associated Penna. Constructors
Overman Cushion Tire Co.
Singer Steel Casting Co.
N. P. Nelson Iron Works
Sweet Steel Company
Chicago Tube & Iron Co.
Hydraulic Hoist Manufacturing Co.
American Hoist & Derrick Co.
Trailmobile Co.
Service Motor Co.
Dow Chemical Co.
G. H. Williams Co.
Simplicity Screener Mfg. Co.
Root Spring Scraper Co.
Kalman Steel Co.
Oklahoma Engineering & Foundry Co.
American Gas Accumulator Co.
Automatic Signal & Sign Co.
American Willite Co.
Taylor Wharton Iron & Steel Co.
Bitucrete Co.
Complete Service Co.
American Malleable & Casting Co.
Sullivan Machinery Co.
Gray Tractor Co., Inc.
Armco Culvert & Flume Co.
E. D. Etnyre & Co.
Kentucky Rock Asphalt Co.
Hastings Pavement Co.
Asphalt Block Pavement Co.
Stockland Road Rachinery Co.
Handy Sack Bailer Co.
Four Wheel Drive Co.
Wehr Co.
Oshkosh Motor Truck Mfg. Co.
Wyoming Shovel Works
Thomas Elevator Co.
Highway Maintainer
Marion Steam Shovel Co.
B. M. Cropp Company
Williams Patent Crusher & Pulverizer Co.
W. E. Godwin Company
Clyde Iron Works
Buckeye Tractor Co.
Noble Motor Truck Corp.
Essco Manufacturing Co.
C. S. Johnson Co.
O. K. Clutch Co.
American Manganese Steel Co.
Orr & Sembower
Curtis Pneumatic Machinery Co.
Fuller & Johnson Mfg. Co.
Universal Crusher Co.
Butler Equipment Co.
Troy Trailer & Wagon Co.
Specialty Engineering Co.
Van Dorn Co.
Buhl Company
Western Contractor
Interflash Signal Co.
Lufkin Rule Co.
American Bosch Magneto Co.
Union Iron Products Co.
U. S. Asphalt Refining Co.
Highway Engineer & Contractor Co.
Twin Disc Clutch
Racine Radiator Co.
Illinois Division of Highways

Graduate Short Period Courses in Highway Engineering

During the past four years the attendance has steadily increased at the graduate short period courses in highway engineering and highway transport at the University of Michigan. In 1919-1920 29 men took the courses and in 1922-1923 there were 119 men in attendance. The average age of the men in attendance last winter was 27 years, varying from 23 to 56 years. They came from the U. S. Bureau of Public Roads, state county and municipal highway departments, consulting engineers' offices, contractors' organizations, university faculties, and manufacturing companies.

The schedule for the 1923-1924 course follows:

Dec. 3 to 14, 1923

C. E. 77. Highway Engineering, Financing, Management and Organization. Professor Swinton.

C. E. 81. American and English Highway Transport Methods. Professor Blanchard.

Dec. 17 to 29, 1923

C. E. 67. Highway Transport Economics and Surveys. Professors Blanchard and Swinton.

C. E. 72. Gravel and Broken Stone Roads, Dust Prevention and Bituminous Surfaces. Professors Blanchard and Swinton.

Dec. 31, 1923, to Jan. 11, 1924

C. E. 73. Brick, Cement-Concrete, Stone Block and Wood Block Pavements. Professor Bateman.

C. E. 80. Interrelationship of Highway, Railway and Waterway Transport. Professors Riggs and Worley.

Jan. 14 to 25, 1824

C. E. 68. Bituminous Macadam, Bituminous Concrete and Sheet Asphalt Pavements. Professor Blanchard.

C. E. 82. Highway Transport Costs and Record Systems. Professor Swinton.

Jan. 28 to Feb. 2, 1924

C. E. 69. Highway Laboratory Research. Professor Bateman.

C. E. 70. Highway Structures. Professors Gram and Cissel.

M. E. 40. Mechanism, Operation and Maintenance of Motor Trucks, Tractors and Trailers. Professor Lay.

Feb. 11 to 14, 1924

The annual Michigan Conference on Highway Engineering.

Feb. 18 to 29, 1924

C. E. 71. Highway Specifications, Contracts and Jurisprudence. Professor Riggs.

C. E. 84. Highway Transport Management. Professor Swinton.

March 3 to 14, 1924

C. E. 76. Highway Engineering Theory and Design. Professor Swinton.

C. E. 78. Grading Machinery and Operations, Drainage Systems and Earth and Sand-Clay Roads. Professor Bateman.

C. E. 79. Highway Transport Legislation and Traffic Regulations. Professor Blanchard.

Statement of the Ownership, Management, Circulation, Etc., Required by the Act of Congress of August 24, 1912,

of ROAD AND STREETS Monthly issue of ENGINEERING AND CONTRACTING, published monthly at Chicago, Ill., for October, 1923.

State of Illinois, County of Cook, ss.

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared E. S. Gillette, who, having been duly sworn according to law, deposes and says that he is the Circulation Manager of the publication Engineering and Contracting, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Engineering and Contracting, 221 East 20th Street, Chicago; editor, H. P. Gillette, 221 East 20th Street, Chicago managing editor, H. P. Gillette, 221 East 20th Street, Chicago; business manager, Lewis S. Louer, 221 East 20th Street, Chicago.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.) H. P. Gillette, 221 East 20th Street, Chicago; Lewis S. Louer, 221 East 20th Street, Chicago; R. E. Brown, 904 Longacre Bldg., 42nd St. and Broadway, New York.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

E. S. GILLETTE, Circulation Manager.

Sworn to and subscribed before me this 1st day of October, 1923.

(Seal) KITTIE C. WOULFE, Notary Public. (My commission expires Feb. 9, 1926.)

Water Works

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.
221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*
LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 904 Longacre Bldg., 42d St. and Broadway
RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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(b) Road Maintenance
(c) Streets
(d) Street cleaning

Railways—3rd Wednesday, $1
(a) Steam Railway Construction Maintenance
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(c) Sewers and Sanitation
(d) Waterways

Buildings—4th Wednesday, $1
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures

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Vol. LX. CHICAGO, ILL., NOVEMBER 14, 1923 No. 5

Utility Betterments and Extensions

Probably nowhere more than in the matter of needed betterments and extensions do our water works and other public utilities still feel the effect of the war and post-war price increases. Maintenance suffered for a while, but it could not be dropped below a certain level if service was to be continued at all; and in fact long before that level was reached managements were exerting themselves to save losses in their property through avoidable depreciation. But betterments frequently could be delayed, even though admittedly needed; and the ever difficult problem of financing aggravated by war conditions, resulted in postponement after postponement. The result shows in a varied assortment of inadequacies in cities scattered throughout the country.

One cannot deny and ought not to minimize the contrary danger of extravagance. Money tends to burn its way out of public funds about as readily as through private pockets but it is not these cases that we are considering now.

Utility betterments may be considered in three general classes—those based upon improvements in the arts, those required by improved standards or changes in the character of use, and those resulting from growth in the community. The first two classes are obviously the easiest to postpone—especially under the non-competitive conditions enjoyed by most water works, but the advisability of postponement is not a corollary of its ease. If more economic means of rendering the service have been developed the retention of an antequated system will impose an unjustified, though seldom an unbearable burden upon the users. If it is improved standards of use that are lacking, the public is simply being deprived of the benefit of modern advances.

Growth of community falls into two quite distinct sub-classes in relation to its requirements. The first of these consists in increases of popu-

lation or of industry within areas already served by the utility. If the utility system has been well planned, provision for some such growth will usually have been foreseen and provided for. When growth progresses beyond this point inadequacy results. Business and even growth may continue but the price is inevitably paid in decreased economy, safety, comfort or otherwise. Take for example, the much needed trunk sewer which the taxpayers of Los Angeles were so reluctant to authorize. It became both a nuisance and a menace but did not check the growth of population. The other class of community growth is that of areas outside the territory already served. Such areas can make but meager development until they are properly provided with modern utility service. To be sure there are numerous residential developments in which public services are well provided by the promoters, but on the other hand many territories are held in a backward condition as to either industrial or residential development simply because they lack these improvements.

In all cases the managements of the utilities—either publicly or privately owned—are confronted with economic problems of no small difficulty. Yet their solution is imperative in the interest both of public and of utility. For the present our water works, sewers, and some other utilities are inadequate in very many places, and the expenditure of reasonable sums on betterments and extensions would be of universal benefit. The futility of further delays in the hope of reduced prices should now be completely apparent.

To Make Study of Engineering Education

The Carnegie Corporation has set aside $108,000 for a study of engineering education to be made under the direction of the Society for the Promotion of Engineering Education. Of the above sum $24,000 is to be available during the present fiscal year and $12,000 during 1924. If, in the judgment of the Executive Committee, substantial progress shall have been made in this study by Jan. 1, 1925, the balance of the $108,000 will be made available to the Society as follows: $24,000 additional during the fiscal year 1924, $48,000 during the fiscal year 1925.

Asphalt Lining for Drainage Ditches

A process just used to advantage in the Brighton district, Trinidad, B. W. I., for lining surface ditches and the edges of non-drainable ponds as a means for mosquito control is described as follows in the April issue of Public Works of the Navy:

Preparation and Application.—After the bottom and sides of the drain to be lined have been cleaned and graded and both edges cleared of grass for a distant of 1 ft. back, liquid asphalt is spread uniformly over the bottom and sides of the drain and for about 1 ft. on each edge. The asphalt should be applied at the rate of 1 gal. per square yard of drain surface and can best be spread from a hand pouring pot provided with a special spout with an adjustable slit opening. The liquid asphalt is fluid enough to be applied at atmospheric temperature. Sand is then sifted over the face of asphalt at the rate of 1 cu. ft. for 8 sq. yd. of surface. The liquid asphalt at once absorbs the sand. Fire is then started in the drain by means of dry grass or a piece of oily waste, and sanitary oil is sprayed on the fire by means of a hand pump.

The fire soon spreads and ignites the liquid asphalt, which burns with an intense heat, the fire traveling along the drain with the wind. Where combustion is not complete additional oil is sprayed on the flame. In practice 1 gal. of sanitary oil is used for 10 sq. yd. of surface burned.

On cooling, the drain is found to be lined with a hard, permanent asphalt-and-sand wearing surface, about ½ in. in thickness, which adheres firmly to the underlying soil. The lining resists the scouring action of the flow of water in drains and prevents the growth of vegetation.

Side slopes are preferably about 45°, although in firm clay formation very nearly vertical sides have been successfully lined.

The drains must be perfectly dry in order properly to apply the asphalt.

The cost totals at from 14½ to 20 ct. per square yard of surface treated, which, when about 20 per cent is added for grading and shaping preparatory to lining, gives a per mile cost of approximately $1,500 to $2,000 for a ditch of 21 sq. ft. in cross section.

Water Works and Sewer Contracts Awarded During the Last 45 Months

The accompanying tables show: First, that the waterworks and sewer contracts awarded during the last half of each year exceed in volume those awarded during the first half; second, that there is not a month in the year without a very large volume of waterworks and sewer contracts; third, that each year shows a gain over its predecessor in the volume of contracts awarded in this "hydraulic field."

The volume of irrigation and drainage contracts will surprise any one who has not followed closely statistics of this sort.

WATERWORKS CONTRACTS EXCEEDING $25,000 IN SIZE.

	1920	1921	1922	1923
January	$ 1,144,000	$ 519,000	$ 1,727,000	$ 4,720,000
February	2,172,000	2,927,000	652,000	2,730,000
March	2,213,000	2,028,000	1,093,000	15,149,000
April	2,719,000	3,342,000	2,673,000	8,544,000
May	1,382,000	4,944,000	3,568,000	7,329,000
June	1,461,000	3,485,000	5,124,000	4,045,000
July	3,793,000	3,106,000	811,000	3,803,000
August	775,000	2,404,000	4,494,000	3,678,000
September	743,000	1,487,000	3,906,000	2,881,000
October	11,169,000	900,000	7,686,000	.....
November	2,151,000	4,698,000	2,161,000	.....
December	1,051,000	10,752,000	1,835,000	.....
Total	$30,773,000	$40,602,000	$35,730,000	.....

Note.—About 100 per cent must be added to the annual totals to give the grand total of contracts awarded in the United States.

A great deal of waterworks construction is done by directly hired labor and is not included above.

Waterworks buildings are not included above.

SEWER CONTRACTS EXCEEDING $25,000 IN SIZE.

	1920	1921	1922	1923
January	$ 1,864,000	$ 3,147,000	$ 2,267,000	$ 3,322,000
February	623,000	2,445,000	2,462,000	2,131,000
March	1,283,000	2,862,000	3,796,000	4,477,000
April	4,124,000	3,817,000	2,794,000	5,497,000
May	2,315,000	2,162,000	5,722,000	9,052,000
June	2,349,000	3,802,000	5,158,000	6,501,000
July	3,163,000	3,986,000	1,869,000	3,183,000
August	2,437,000	3,988,000	3,450,000	13,753,000
September	2,319,000	5,064,000	3,340,000	10,368,000
October	3,052,000	2,829,000	4,996,000	.....
November	4,572,000	2,733,000	5,349,000	.....
December	2,967,000	2,549,000	2,381,000	.....
Total	$36,068,000	$39,384,000	$43,584,000	.....

Note.—About 100 per cent must be added to the annual totals to give the grand total of contracts awarded in the United States.

A considerable amount of sewer construction is done by directly hired labor, which is not included in the above totals.

IRRIGATION, DRAINAGE AND EXCAVATION CONTRACTS EXCEEDING $25,000.

	1920	1921	1922	1923
January	$ 1,542,000	$ 1,266,000	$ 2,091,000	$ 548,000
February	787,000	306,000	419,000	365,000
March	3,151,000	1,626,000	608,000	28,993,000
April	416,000	580,000	1,736,000	2,506,000
May	404,000	2,632,000	776,000	3,553,000
June	605,000	1,240,000	2,628,000	1,174,000
July	1,942,000	609,000	1,498,000	6,902,000
August	4,179,000	39,000	6,920,000	2,337,000
September	859,000	9,025,000	876,000	3,360,000
October	1,086,000	373,000	2,390,000	.....
November	772,000	726,000	1,741,000	.....
December	477,000	707,000	864,000	.....
Total	$16,220,000	$19,179,000	$22,547,000	.....

Note.—About 100 per cent must be added to the annual totals to give the grand total of contracts awarded in the United States.

Repairing Coagulation Basins With Cement Gun

Method and Cost of Work at Oklahoma City, Okla.

By A. S. HOLWAY
Holway Engineering Co., Consulting Engineers, Tulsa, Okla.

Plans for Oklahoma City's new water filtration plant contemplated making use of the old coagulation basins. These were four in number, built in two groups, one of which was built in 1909 and the other in 1912. The walls of these basins were badly disintegrated above the water line. This disintegration was apparently the result of the action of frost on a porous concrete.

Shooting East Basins. Note Top and Back Forms With Light Bracing and Scaffolds. Forms for Two Walls Were Supported by Single Set of Braces.

Cement Gun Work Was Selected.—A study of the various methods of repairing the walls of the basins indicated that the work should be done with cement guns rather than by ordinary concrete pouring methods for the following reasons:

(1) Forms for cement gun work could be much lighter;

(2) Form bracing for cement gun work could be very light and would only be needed on one side of each wall;

(3) Runways could be eliminated with cement gun work. This was an important item, because the amount of concrete required per lineal foot of wall was less than 3 cu. ft.

(4) Cement gun work would not be subjected to future disintegration to the same extent as poured concrete because of its higher density;

(5) The small water content of guniite made it less liable to freeze than concrete and therefore more applicable to use during freezing weather in a location where it was so difficult to protect.

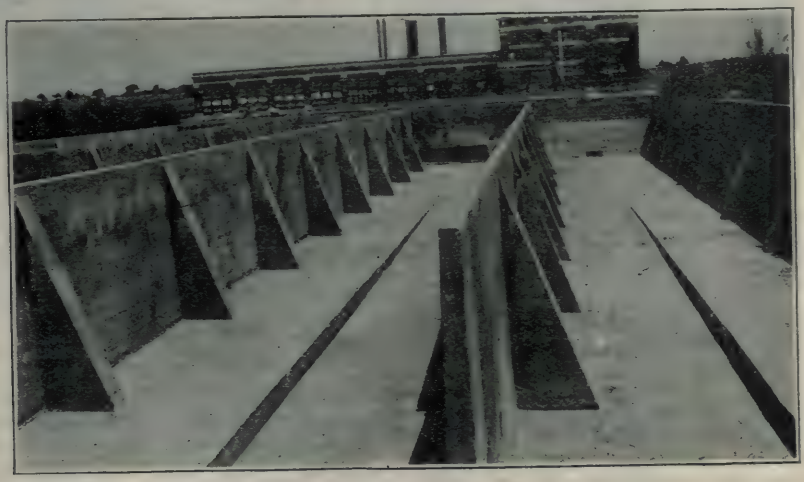
Contract on Cost Plus Fixed Fee Basis.—It was extremely difficult to estimate the amount of disintegrated concrete which must be removed and replaced. It was therefore decided to

award a contract on the basis of cost plus a fixed fee.

The contract as let included the removal of all disintegrated concrete for the walls and rebuilding the walls with gunite mixed in the proportion of one part of cement to three parts sand. The voids in the sand were specified to vary from 25 per cent to 35 per cent. The walls totalled approximately 2200 feet in length and varied from 6 in. to 14 in. in thickness. The basins were 12 ft. deep.

The disintegrated concrete was removed with stone picks, sledges, or cold chisels, depending on the amount of material to be removed. The disintegrated concrete was all removed and the old steel reinforcing rods cleaned with wire brushes. This steel was supplemented in most places by steel wire mesh.

View of West Basins, Disintegrated Concrete Removed.



West Basin With Repairs Completed.

Method of Applying Gunite.—Forms were then placed having one side and a top. The forms were braced against the next wall. The

gunite was mixed at a central point adjacent to the railroad siding. Two N-2 cement guns were used operated by air furnished by two compressors driven by 2300 volt motors.

The nozzlemen worked from movable scaffolds supported by horses. The gunite was shot against the forms for a distance of 4 to 6 ft., and was built up to a full section in two or three vertical layers. The face of the wall was then screeded, using the edge of the top form and the old wall for guides. The exposed face was then flashed with a thin coating of gunite. Forms were removed the following morning and the remainder of the work was flashed.

The total amount of gunite mixed was 292 cu. yd. Estimating the rebound at 15 per cent of the whole, the actual gunite placed was 248 cu. yd.

Cost of the Work.—In view of the fact that the contract was handled on a cost plus basis, the costs quoted below are practically complete in every detail. These costs include cost of shipping equipment to the job, making all of the preparations for starting work, building compressor and cement sheds, removing disintegrated concrete, and clearing up after the completion of the work. The fixed fee covered the use of small tools, office, overhead, and profit. Water was furnished free by the city. Each cement gun equipment, including compressor and motor, was rented on the basis of $15.00 per day for each day in actual use. Sand was $1.40 per ton and cement was $2.80 net per barrel delivered on the job. Common labor was paid 40 ct. per hour. The total costs of the work were as follows:

Item	Total cost	Cost per cu. yd. in place
Power	$ 313.76	$ 1.26
Sand	462.81	1.87
Cement	1,552.95	6.27
Freight and Drayage on Equipment and Miscl.	627.70	2.53
Lumber	643.50	2.60
Steel	209.00	.84
Insurance	200.55	.81
Equipment Rental	1,560.00	6.29
Labor	4,031.75	16.25
Superintendence	717.51	2.89
Miscellaneous Expense	320.83	1.29
Total	$10,640.36	$42.90

The contract was signed early in December, 1922, and the work was completed early the following March. Pratt-Thompson Construction Co., Kansas City, Mo., was the contractor on the work and the writer was engineer in charge of the work.

East Basin With Repairs Completed.

Rainfall at St. Paul, Minn.—The annual rainfall at St. Paul, Minn., for 82 years, 1840 to 1922 inclusive, has averaged 27.47 in., according to a table in 1922 report of Mr. Wm. J. Peters, Commissioner of Public Works. The maximum yearly rainfall was in 1849 when 49.69 in. fell; the minimum rainfall was 10.21 in. in 1910.

Operation Records for Small Water Works

Their Value, the Existing Situation, and Methods of Improvement Discussed in Paper Presented at Last Annual Meeting of Iowa Section of American Water Works Association

By EARLE L. WATERMAN
Associate Professor of Sanitary Engineering, University of Iowa

It is rather difficult to define the term small water works. In a paper on "Modern Pumps for Small Water Works", which was published in the Journal of the New England Water Works Association in March, 1920, Mr. C. W. Fulton includes under small water works those plants which have a daily capacity of 3,000,000 gal. or less. Such a classification may perhaps serve the purpose of this discussion although the writer feels that in the Iowa plants whose capacity is 500,000 gal. or more per day some effort is generally made to keep records of operation. While in most cases these records can be improved—particularly in those plants which under our classification may be called small water works—it is in the smaller plants whose capacity is less than 500,000 gal. per day that the greatest improvement can be made. Definite data concerning the number of these plants are not available but from such information as could be obtained the writer estimates that out of 500 plants in Iowa 490 would be classed as small water works and of this number, 464 have a capacity of less than 500,000 gal. per day.

What Records Should Show.—The records which ought to be kept at a water works plant should show all facts relating to the operation of the plant. In a broad sense the keeping of such records may be called bookkeeping or accounting. However, properly kept records will not only show costs of operation, but will also show pertinent facts in regard to the quality of the product and point to reasons for variations in quality. A successful water works plant is one which supplies water, which is satisfactory from every standpoint, to its customers, and also gives good service at a minimum cost. The facts in regard to the operation of such a plant should be kept in permanent form so that they may be always available. We profit by experience—the operating records should be a complete record of experience obtained in operating a water works plant. When it is too late we often find that the memory of the plant superintendent is not as trustworthy as a written record.

The operating records should include an inventory of all plant equipment, a record of the amount of water furnished to the distribution system each day, amount of power used per day, pressure maintained, occurrence of fires, labor costs, plans of the distribution system, all changes in the distribution system, installation and removal of meters, meter testing, quantities of chemicals used for treatment, data concerning treatment, and the results of the examination of all samples of water which are analyzed to determine the quality. It is probable that other items should be included—this is not a complete list by any means and is offered only for the purpose of suggesting what the writer has in mind when he uses the term operating records. It will be noted that aside from labor costs, which are a factor of operating costs, the financial items are not included and the reason for this omission is that such records do not always come under the province of the superintendent of water works. It is not our purpose to discuss the important matter of the determination of water sales rates.

Value of Records to Operator.—The operating records should be of the greatest value to the plant operator. Such records ought to enable him to operate the water works plant in the most efficient manner. The efficiency of the plant units as well as the efficiency of the plant as a whole can be determined. If the plant is not operated continuously a study of the operating records should show at what times and for how long a period the plant can be most economically run. It should show him the variations in quantity of water available at the source of supply and the variation in ordinary demand together with the effect of fire demand. The record

would show the effect of the seasons both on the quantity and quality of water and on the plant and distribution system. Some one will say that the old operator knows these things. In a general way this is true but such information cannot be as reliable as the written record, and the new man coming on to the job does not inherit his predecessor's memory! Properly kept operating records should be invaluable to the man who makes them.

Use of Records in Making Out Reports.—The making out of reports to State Board of Health and to State Public Utilities Commission will be very much easier for the man who keeps a daily record of his plant operation. These state supervisory authorities are not unjust in their requests for information. The object of such supervision is to protect the health and the pocket book of the citizens of the state. Speaking only from the standpoint of the water utilities we must admit that the primary function of such public utilities is first to furnish a safe and satisfactory water, and second, to supply such water to the consumer at a reasonable cost. Then the question arises as to who is to determine whether or not these requirements are being fulfilled? The consumer knows whether or not the water is satisfactory but he is a poor judge of its safety and has very little knowledge on which to base an opinion as to the cost. Safety and cost are matters to be determined by specialists and for the small water works the services of qualified experts in such matters is not feasible from an economic standpoint. When such advisory service is furnished by the state plant operators should realize its value and by hearty co-operation obtain maximum benefits from it. Operating records make such co-operation possible and not a burden.

The Need for Past Records of Plant Operation.—Most small towns and cities have the laudable ambition to grow and history shows that a majority of them do increase in size. Growth means enlargement, extension and improvement of the waterworks plant. When these matters come up for consideration the first inquiry made by the engineer who is to make the plans is for the past records of plant operation. On the basis of such records he is able to forecast more accurately the probable future demands and plan for a plant that will furnish a safe, satisfactory and economical water supply. The degree of success which he attains will be largely measured by the data which he finds available. Operating records are valuable in planning improvements to the water works plant.

At a majority of the water works plants in Iowa where some form of purification process is used operating records are being kept. The chief of the water laboratory of the State Board of Health has been making a very commendable effort during the past two years to encourage the keeping of such records. If the plant operator keeps only a duplicate of the weekly reports which are required by the State Board of Health he will at least have a fair start on operating records.

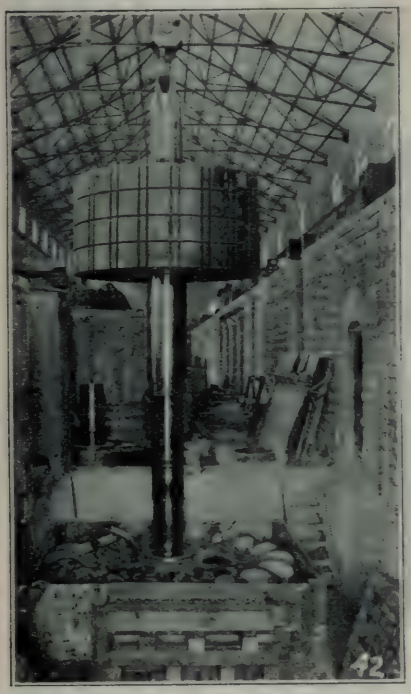
Obstacles in Way of Getting Operating Records.—Perhaps the most serious obstacles in the way of getting operating records at small water works are, first, lack of proper equipment and record forms, and second, the fact that in many cases the operation of the water works plant is only a part of the duties of the man who is city marshal and superintendent of streets. Probably not more than one-fourth of his time is devoted to the water works. With so many things to claim his attention it is not surprising that he does not keep records at the water works.

If such records are to be obtained it is essential that simple forms be planned and further that some equipment for measuring pressures and recording the amount of water furnished by the plant be installed. A recording pressure gage will be very helpful to the operator. Venturi meters or master flow meters may be used to determine the daily flow. If it is not possible to install a meter a stroke counter on the pumps at pumping plants may be used. Where the plant is not run continuously the time of starting and stopping should be recorded. In the smaller plants the furnishing of a diary or log in which daily notes can be made may serve to encourage the operator to make some records.

Shrink-Fitting Heavy Shaft Assembly

Novel Method of Assembling Shaft, Rotor and Water Wheel Runner

When installing the equipment for the hydroelectric plant of the Andhra Valley Power Supply Co. near Bombay, India, C. V. Foulds, Field Engineer for the Pelton Water Wheel Co. of San Francisco, developed a novel method of assembling shaft, rotor and water wheel runner. For the particular conditions of the job, this method proved much superior to the conventional press-fit.



Shaft Suspended from Clamps, and About to Be Lowered Into the Steam-Box for the First Spider.

The plant comprises six 10,000 k. v. a. General Electric generators, each driven by a single overhung Pelton impulse turbine. Besides the hydraulic equipment, Mr. Foulds and his assistant, W. L. Parker, installed the generators as well. The only labor available was native and was mainly unskilled.

Each shaft assembly comprised four rotor spiders weighing 8 tons apiece, the water wheel runner weighing 12 tons, and the shaft itself weighing 9 tons—a total of 53 tons. The final assembly weighed 73 tons, but the 20 field poles for the rotor, weighing a ton apiece, were naturally not added until the rest of the assembly was completed. The bore of runner and spider hubs was 0.003 in. smaller than the shaft diameter which was 22 in.

Largely on account of the lack of skilled labor, it was decided to heat spiders and runner by steam and shrink them on rather than employ the usual press-fitting methods. However, events proved that shrink-fitting would have been advantageous irrespective of the character of the labor supply.

Shaft Being Turned, Showing Block to Keep Weight Off Buckets.

A "steam box" large enough for one of the rotor spiders was constructed, and a spider lowered into it. Steam was then supplied by a 1-in. pipe from a donkey boiler outside the building. Four or five hours of steaming was required, which increased the diameter of the bore from 0.003 in. less than the shaft to 0.012 in. more.

Further steaming made only a slight additional increase, the time allowed being apparently sufficient to bring the spider up to approximately the temperature of the steam.

The first spider to be applied was necessarily the one next to the outboard bearing, so that in up ending the shaft for insertion, it was necessary to grip it by a friction clamp over the journal itself, as there was no collar to keep the clamp from slipping off. The clamp used was composed of two 12 by 12 in. teak timbers fitted to the curvature of the journal, and held together by two pieces of 12 in. I-beam 3 ft. long with 3 1½ in. bolts at each end. Forged links of 1½ in. steel were looped over the double hook of the crane.

At the conclusion of the required steaming period, the steam was shut off and the box opened. The bore was then wiped out and its diameter checked before inserting the shaft, which went in easily. For the first spider on each shaft a stop was attached to prevent the shaft going too far. The other spiders stopped against the ones already in place. After the first spider had shrunk in place, the lifting clamp was removed and subsequent hoisting done with slings through the spider.

To guard against looseness in the main key and to insure alignment of the pole slots of the four spiders, a long key with one end tapered was made to fit the slots exactly, and as each pair of spiders came together it was inserted and left in place until the last spider to be added had cooled and gripped the shaft. The time of cooling was prolonged as much as possible, 12 hours being usually allowed for it, although the hub commenced to grip the shaft after one hour.

Aside from the cleaning and preparation of hubs and shaft that would be required whatever the method of assembly employed, the actual work for each hub required one man for 8 hours to tend the boiler, and the crane and four men for two hours to make the insertion and later to withdraw the assembly and place another spider in the box. The same procedure was followed for the turbine runner except that a slightly larger steam box was required and seven hours steaming instead of five. In one instance all five hubs were set on a shaft in as many days.

When the shaft assembly, weighing 53 tons had been completed, and was hanging from the crane with the turbine runner down, an overhanging step was provided on one of the pit walls, on which was rested the outer hub of the runner, permitting the entire assembly to be lowered to a horizontal position without placing any weight on the buckets. The assembly was then picked up again and set in the bearings.

Shaft Assembly On Its Way to Final Position. Total Weight 53 Tons.

Stream Line Filters

New Development in Filtration Described in Paper Read Oct. 16 at Meeting on Pollution of Streams by Industrial Waste at Engineers' Club, Philadelphia

By GEORGE W. FULLER
Consulting Engineer, New York and Philadelphia

Stream line filters were one of the most interesting exhibits at the Shipping, Engineering and Machinery Exhibition at Olympia, London, last September. They are the invention of H. S. Hele-Shaw, D. Sc., LL. D., F. R. S., a well known inventor of mechanical appliances, a distinguished professor of Engineering in earlier years at Liverpool and in South Africa, and last year President of the British Institution of Mechanical Engineers.

The Antecedents of the Filter.—The principle of this filter was discovered last winter while experimenting with lantern projections to indicate the behavior of films under pressure in connection with the Theory of Stream-Line Motion, established by Dr. Hele-Shaw. Announcement of the discovery was made before the Royal Society May 10, 1923, and the formal paper attracted so much interest that this Society requested a demonstration of its practical application at its Annual Soiree on May 16. So intense was the interest in the use of this highly scientific discovery that a second demonstration was given by request of the Royal Society on June 12. Descriptions and demonstrations were also given before the Royal Institution on June 1, before the Society of Chemical Industry on June 4, when a commercial-size filter was first shown, and before the Institution of Civil Engineers on July 12. So much for the antecedents of this device, which has been patented, prior to its exhibition before the general public at Olympia, Aug. 31 to Sept. 22, 1923.

What the Filter Is.—The stream-line filter in its simplest form is made of a pack of specially prepared paper, impervious to water and oil and somewhat roughened to provide passageways, the pack being held within a container between two press-heads. One of the pressheads is movable and provided with a screen arrangement for suitably compressing the many hundreds of sheets which make up the paper pack. Through the entire pack from press-head to press-head are two alternate sets of circular holes, the larger being for the influent and the smaller for the effluent. At one press-head are channels through which, under such pressure as desired, the influent is led to each of the openings of larger diameter; and at the other press-head are channels connecting with the smaller holes in order to remove the effluent. The influent, even under heavy pressure, can pass from the larger tubular openings only through the laminae of the heavily compacted pieces of paper, with stream line motion, into the smaller tubular openings which form an exit from the filter. The latter is equipped, at the press-heads, with rubber joints and other minor arrangements, which vary with the size of the unit and need no description here.

These filters are built of the horizontal or vertical type. The largest stream line filter exhibited at Olympia consisted of a battery of 16 vertical filters, each pack containing 16,000 sheets, 256,000 sheets in all, with 32 influent openings making the total number of filter units 8,192,000. Its rated capacity is 10,000 gal. per hour.

How the Filters Are Cleaned.—Stream line filters require cleaning at intervals, depending upon the quantity and quality of influent filtered since the preceding cleaning. This is done in one or both of two ways. Either the deposit on the walls of influent tubular openings is pushed through suitable ports in the press-head by means of light, free-fitting pistons which are actuated by the pressure normally used in forcing the influent through the filter; or, the deposit is removed by forcing the effluent back through the effluent openings, through the laminae of the compressed paper pack, thence through the walls of the influent tubular openings and out through a suitable port. Obviously the cleaning operations are to be adjusted to the work done by the filter. That is, consideration is given to whether the purpose is to obtain the separation of solids or colloids, or to free a liquid of undesirable matters contained in it. I saw several packs of paper dismantled after more or less use in fil-

tering various substances and I was impressed by the complete absence of stain or other sign of service by the paper, other than at the edges of the influent openings.

Accomplishments of edge filtration, as distinguished from ordinary filtration through a body of granular material, depend upon the ability to regulate the attenuation of the films in which the liquid passes in stream-line motion. It is essential that the material used in this new filter have a rough surface so as to provide passage-ways, as satisfactory results do not appear to be obtainable with smooth surfaces. The special paper now used is not only impervious and relatively cheap, but its flexibility allows pressure to be applied to the packs in varying degree, thus providing a control for the size of the passage-ways. As a result of passing certain mixed liquids through the stream line filter several times, and increasing the pressure on the paper pack between each filtration, it is understood that different substances are removed each time, thus accomplishing what for convenience has been designated as "fractional filtration." It may be mentioned that the paper in use is said to withstand ordinary acid solutions up to 10 per cent strength, but that filtration is interfered with by alkalies approaching 1 per cent.

What the Stream Line Filter Will Do.—As to the work which the stream-line filter will do, it is not easy in a few words to do justice to the discovery of Dr. Hele-Shaw. For present purposes it is sufficient to record some of its accomplishments, as follows:

Removes the color or stain from moorland swampy water.

Produces a colorless effluent from a solution of Erythrosin when diluted with 5,000,000 parts of water, and having a brilliant orange color with fluorescent green glint.

Produces from milk a clear effluent, nearly tasteless.

Extracts the oil from feed water.

Separates water and impurities from oil.

Extracts 30 per cent of the salt in sea water.

Decolorizes unrefined sugar.

Separates cyanogen from gas house sludge.

Reduces dilute activated sludge to a 60 per cent water content.

Enough has been said to indicate the wide range in style of performance which may be obtained from this discovery of Dr. Hele-Shaw. I have never seen an invention which has attracted so much favorable attention from such widely different groups of men. Its accomplishments have aroused not only those engaged in scientific investigations, but also the engineer, the chemist, the bacteriologist and the manufacturers engaged in many industries. Its commercial uses are being eagerly investigated at the same time that laboratory men are discussing its utility in their work. Discussions by English scientists have already suggested many interesting possibilities, including the grading of bacteria of different sizes, the concentration of enzyme solutions and the separation (by using sufficient pressure) of ultra-microscopic microorganisms.

It is too early, of course, to say much as to the economic worth of this filter in the industries or to outline the scope of its benefits to science. But the indications are that it will have a bright future along many lines of activity.

As I left London a couple of weeks ago I was informed that an American company, to develop this invention in this country, was about to be formed, and that perhaps arrangements would be made to demonstrate its performance at the National Exposition of Power and Mechanical Engineering Show at the Grand Central Palace in New York, during the first week in December. However, announcements as to its introduction in this country will have to come from those having the matter directly in hand.

Baltimore Votes $10,000,000 for Water Works.—The citizens of Baltimore, Md., at the election on Nov. 6 authorized a loan of $10,000,000 for water works improvements. The principal projects include the development of a new source of supply or enlargement of existing impounding works and construction of a new supply tunnel, at a cost of $4,000,000; general extension of the system for new consumers at a cost of $1,000,000; and the installation of water supply and distribution mains to cost $4,000,000.

Fitting the Electric Motor to the Pump

A Practical Discussion on the Application of Electric Drive to a Fundamental Operation in Industrial Plants

By R. H. ROGERS,
Power & Mining Engineering Department, General Electric Co.

Pumping is a fundamental operation in all industrial plants which lends itself admirably to electric drive. The selection of pumps, motors and control for the most successful operation under all conditions and circumstances is not a simple problem and if not well studied out the plant is penalized continuously through the following years. The fact that some of the major industries with well organized engineering departments are operating many pumps with characteristics entirely unfitted for the service would indicate that this branch of especially for those who have little time for an intensive study of these problems.

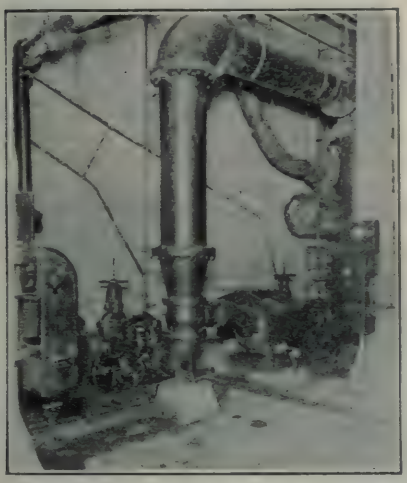


Fig. 1. Sulphite Stock Pumps in Paper Mill.

The clearest way to show all the elements that effect the over all efficiency of electric pumping units is to analyze the whole span from the electric meter to the work accomplished, not overlooking other items that make an installation successful. The items that directly affect the kilowatt hours per million gallon feet are given below.

Ratio of Dynamic Head to Static Head.—The vertical tape measurement from level to level or the calculated head if pumping against say boiler pressure is not the measure of the pump work. Every foot of pipe, every valve, every elbow or other fitting adds to the theoretical to make the actual or dynamic head.

For instance, considering only pipe diameter, a 5 in. three stage centrifugal delivering 400 gpm. through 300 ft. of 5 in. pipe will cost $375 per year more to operate than if a 10 in. pipe were used. This differential would pay for the larger pipe in a year. Tables of heads to be added for sizes of pipes, valves, elbows, etc., at various velocities are available in pump catalogs and handbooks and they deserve close consideration.

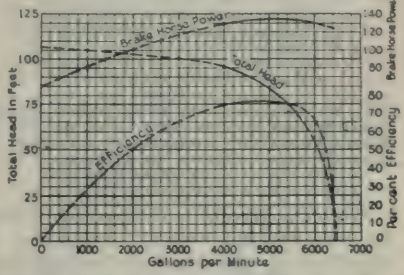


Fig. 2. Typical Curves for 12-in. Centrifugal Pump at Constant Speed.

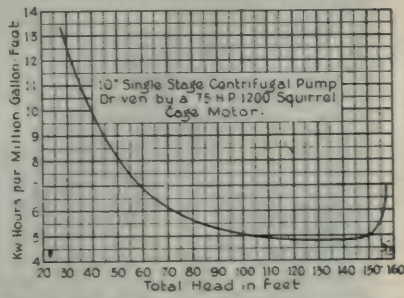


Fig. 3. KW. Hours Required for Million Gallon-Feet at Various Heads for 10-in. Centrifugal Pump Driven at Constant Speed.

In general the piping should have much greater area than the pump openings as high velocity is essential

in the pump but very detrimental in piping. Six to eight feet per second should not be exceeded and less is desirable, for, once installed, the loss goes on for years.

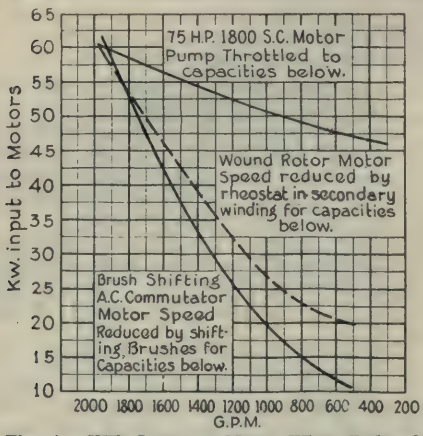


Fig. 4. KW. Input to Motor When Reduced Pump Output Is Secured by Throttling at Constant Speed; by Reducing Speed Using a Wound Rotor Motor; by Reducing Speed Using a Brush Shifting Motor.

The suction pipe especially should be deeply immersed, should be as short as is practical, consistent with good installation practice and the bends, if any, should be of long radius.

An excess of dynamic head over static head means just that much more work for the motor forever after and if it is 10 per cent or 50 per cent, that excess will show up at the meter.

Figure 1 shows pump installations with no suction lift as they are placed alongside the sulphite stock tank. The piping is very liberal in size so that the difference between dynamic and static head is slight.

Pump Characterictics.—Head, gallons per minute, efficiency, revolutions per minute and horse power plotted together show the character of a centrifugal pump. If the speed at the point of best efficiency is at or near an induction motor speed, viz.: 1730, 1150, 865, 690 or 575 it will insure its operation at the most efficient point if direct connected to a squirrel cage induction motor.

If the horse power required at the most efficient point is near one of the standard squirrel cage motor ratings, viz.: 200 hp., 150 hp., 125 hp., 100 hp., 75 hp., 60 hp., 50 hp., 40 hp., 30 hp., 25 hp., etc., it will insure a high over all efficiency for the set. Fortunately, induction motors have a very flat efficiency curve through the working range such as 90 per cent at full load; 90.5 per cent at 75 per cent load and 90 per cent at 50 per cent load so that this feature has little effect. However, the power factors of such motors require that they be operated to a minimum. Power factor affects

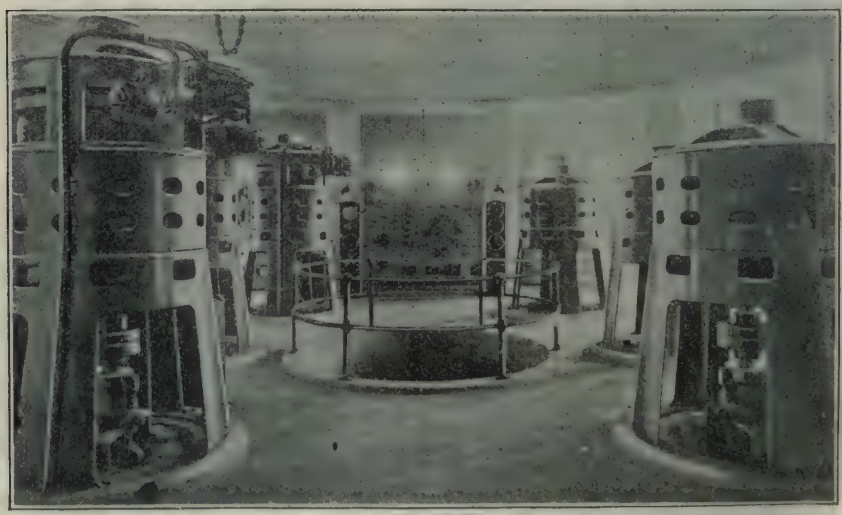


Fig. 5. Motors at Right Are Brush Shifting Type With Pilot Motor Control. Motors at Left Are of Squirrel Cage Type. All Driving Centrifugal Pumps.

only the leads and generating system and not the meter except as the rates

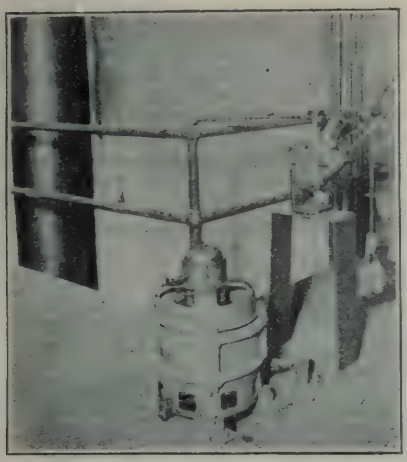


Fig. 6. 15 Hp. Vertical Squirrel Cage Sump Motor With Float Switch Control.

may be adjusted to penalize low power factor in a plant. At loads as above, the power factor may be in the order of 89 per cent, 87 per cent and 80 per cent.

A desirable characteristic in centrifugal pumps is that of having the load fall off each way from the best operating point. This prevents an overload coming on the motor by an accident or mishandling of valves which would subject it to maximum head (closed off) or minimum head (direct discharge).

Figure 2 shows typical centrifugal pump curves for constant speed. The efficiency is high and fairly flat from 80 ft. to 97 ft. head and from 4,000 to 5,600 gpm., hence the pump could be efficiently applied between these limits. The horse power falls off both ways so that the motor cannot be overloaded.

Operating Off Rating.—Pumps are rated naturally at their best operating point and any deviation in speed, head or delivery will result in a higher cost per unit of duty.

While some future conditions may have to be given consideration, operating at lower than rated head should be avoided especially where a constant speed motor is used. Fig. 3 shows the variations in KW hours per million gallon feet pumped by a 10 in. centrifugal direct connected to the constant speed motor which gives the highest over all efficiency at the pump rating.

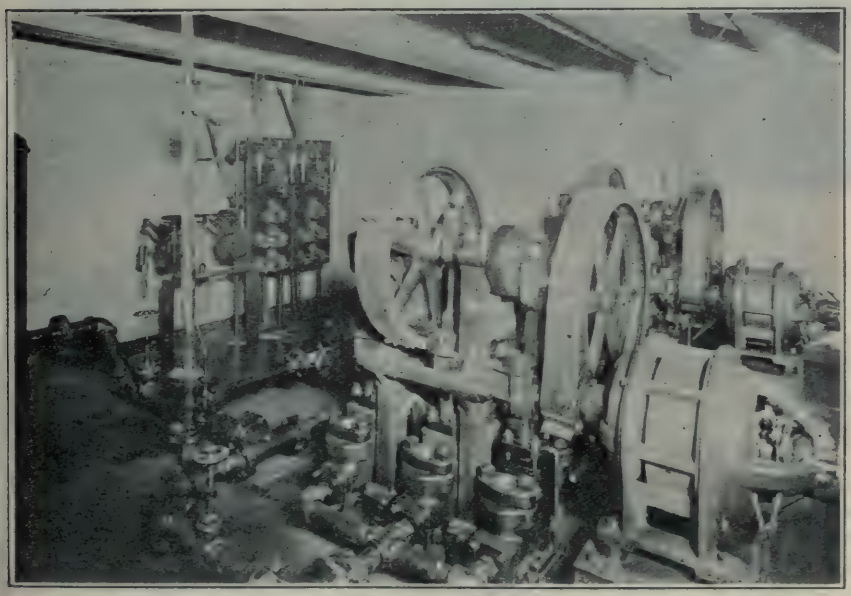


Fig. 7. Wound Rotor Motors Controlled by Automatic Panels and Float Switches.

The gallon-feet pumped in a year at 1235 ft. head for $9,100 (2 ct. per KW hour) would cost $17,000 if pumped at 45 ft. head with pumps of this class. This difference of $7,900 per year is not out of line with many pumping duty costs that may be found among the misapplied pumps in industrial plants.

Choice of Pumps.—For constant speed service either induction motors of the squirrel cage type or synchronous motors may be used. Synchronous motors improve the power factor for the plant and this item may be enough to justify the valve manipulation incident to starting centrifugal pumps with such motors, together with the complication of bringing D. C. excitation to the motor. There is little difference in the efficiencies of the motors mentioned.

For direct current service the shunt wound motor is not well adapted for centrifugal pump drive, as they are too sensitive to load and voltage changes. A compound wound motor should be used with only a moderate series field, say 10 per cent, and such motors have been standardized for centrifugal pump service.

For adjustable speed pump drives, wound rotor motors, or the brush shifting, commutator type of motors may be used. The latter have much higher efficiencies at reduced speeds and this justifies their higher cost if operated at below normal speed frequently or for long periods. Fig. 4 shows the relative outlay in KW. hours for an adjustable speed pump using wound rotor and brush shifting motors. The third curve shows the high cost of throttling to get reduced output.

It will be noted that at 60 per cent of normal pump output, the brush shifting motor would operate 24 hours for $10.72; the wound rotor motor for $14.88; the squirrel cage with throttled pump for $25.20. The differences become greater upon reducing the output still more.

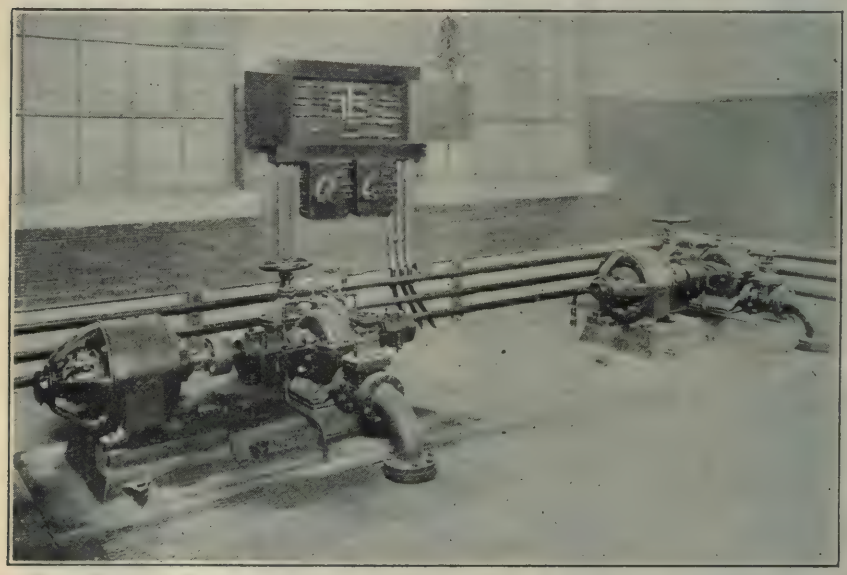


Fig. 8. Compound Wound Motor Operating Pump in Nitrate Plant.

Vertical motors may often be used to great advantage by locating the pump at whatever depth may be necessary below the motor room floor. This reduces or eliminates the suction lift with consequent benefit to the over all efficiency. Where grit is present in the water or the pump is inaccessible the entire weight of the revolving parts may be carried on a suspension thrust bearing at the top of the vertical motor. This allows of easy inspection and maintenance. Vertical motors are available in synchronous, squirrel cage, wound rotor, brush shifting and direct current construction.

Figure 5 shows three brush shifting vertical motors at the rigth and three squirrel cage vertical motors at the left all driving centrifugal pumps.

Squirrel cage motors can be used on centrifugal pumps up to 500 hp. provided the inrush of starting current is not objectionable. Wound rotor motors start with much less line disturbance and are used for that reason even when intended for constant speed duty. Synchronous motors are not usually installed below 75 hp. and are of course for constant speed duty only.

Reciprocating pumps, rotary pumps and screw pumps have heavy starting duty due to high breakaway torque and full load pumping duty from start. For these reasons squirrel cage motors cannot be used if line disturbance is objectionable. Synchronous motors can be used but the pump must be relieved of its load in starting so that the motor can pull into step. Wound rotor motors for A. C. and compound wound motors for D. C. are best for pumps of this class, as they are possessed of strong starting characteristics. The brush shifting commutator type of A. C. motor is equally good where adjustable speed operation is desired.

Pump Control.—Squirrel cage motors are controlled by manual or automatic compensators to which may be attached disconnecting switches and ammeters. The automatic compensators may be actuated by a push button at some convenient point, by a float switch, by a thermostat or by a diaphragm pressure switch. Fig. 1 shows a manual compensator with ammeter attached. Fig. 6 shows a vertical squirrel cage motor direct connected to a sump pump and controlled by a float switch through an automatic compensator.

Wound rotor motors for constant speed duty are controlled by au automatic panel actuated by push button, float switch or the like. Fig. 7 shows wound rotor motors controlled by automatic panels and float switches. The heavy starting duty on the reciprocating pumps determined the type of motors used.

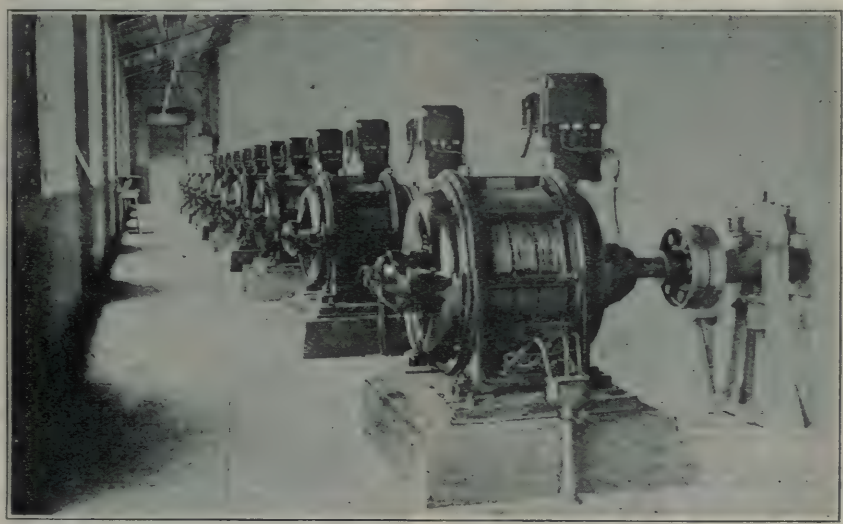


Fig. 9. Motors Driving Gasoline Pump. Oil Switch Starters.

Where adjustable speed is required or it is desired to control the starting by hand, a manual rheostat is provided in the secondary circuit while the line contact is made by a manual or magnetic switch. Synchronous motors are commonly controlled by a compensator and a field discharge switch.

Brush shifting motors require only some form of line switch with overmeans for shifting the brushes. This may be a hand wheel, a shipper rod or small pilot motor actuated by remote push buttons. Reference to Fig. 5 will show this form of speed control on the three brush shifting motors at

the left. The master panel is in the center background.

Compound wound direct current motors for centrifugal pumps require a disconnecting switch and a hand starter. If adjustable speed is required a manual field regulating rheostat is added.

Direct current motors may also be controlled by magnetic panels actuated by push button, float switch or the like as in the case of the A. C. motors. Fig. 8 shows compound wound motors in a nitrate plant controlled by fused disconnecting switches and hand starters all neatly arranged.

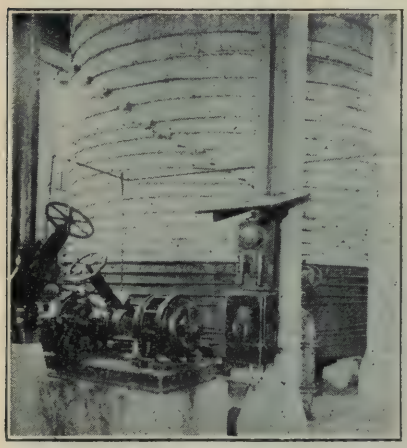


Fig. 10. 40 Hp. Squirrel Cage Motor Driving an Acid Pump and Exposed to Acid Fumes.

Control apparatus in all cases should be fully enclosed and provided with overload and undervoltage protection. Where it is desired to have the motor resetart by itself after an undervoltage shut down, undervoltage release should be specified. Undervoltage release must also be provided if the motor is to be started by a float switch or other auxiliary circuit closing device.

The presence of explosive gases or of especially corrosive acid fumes necessitates the submergence of contact making parts in oil. Such control items are available for all classes of pump service. Fig. 9 shows a battery of motor driven gasoline pumps in a refinery. The switches are of the oil immersed type and as a squirrel cage motor has no moving contacts there is no danger of starting a fire or explosion.

Figure 10 shows an acid pump being driven by a forty horsepower squirrel cage motor, which is in no way injured by the fumes as there are no vital parts exposed. This motor is controlled by a standard compensator which has it contacts submerged in oil.

105,000 Hp. Hydro-Electric Development Placed in Service

On Oct. 11 the Southern California Edison Co. put into complete service the largest hydro-electric power house on the Pacific West. This plant has an output of 105,000 Hp. and is an important step in the $375,000,000 development project in the High Sierras of California. The electric energy from the new plant is transmitted on lines 275 miles in length, at 220,000 volt pressure, the highest voltage at which electric energy has ever been transmitted.

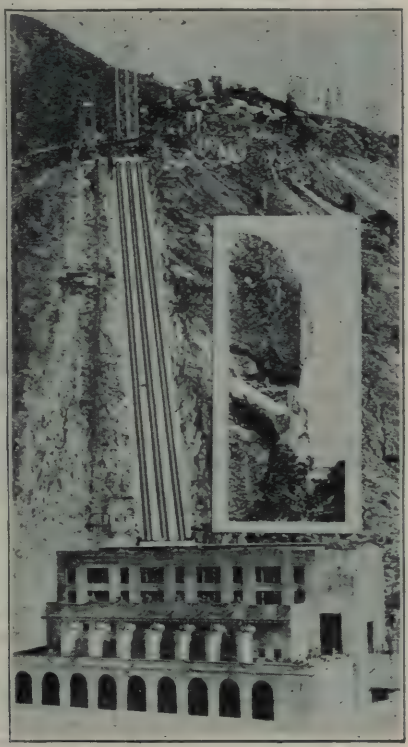
The 105,000 Hp. which the plant generates is supplied by three 35,000 Hp. distinct generating units of the latest type. These are propelled by diversion of the waters of the San Joaquin River through a tunnel six miles in length which has its upper portal at a new dam which the company has thrown across the main stream. Three pressure mains drop the water on the generating machinery at a fall of 760 feet.

The power house proper is of steel and concrete construction and of the latest type, the building being 200 ft. in length, 135 ft. wide and 110 ft. high from the tailrace floor to the roof which is of reinforced concrete and structural steel. Excavation for this building which was carried on by means of hydraulic sluicing and steam shovels, was started on June 15th, 1922, and the first concrete was poured in the foundations on Jan. 10th, 1923. The power house structure contains the generators, but the switching station is of the outdoor type and becomes a part of the first installation of 220,000 volts ever to be placed in actual operation. The generating room of the power house is 55 ft. in width and 70 ft. high and the building is equipped with a 125-ton electric crane.

Novel Features of the Plant.—There are many novel features of this plant, one of which is the omission of a separate lubricating oil system. In

this installation each bearing of the main unit has its own lubricating oil pump, thus eliminating all outside oil filters, pumps, supply tanks and piping, which are liable to cause more or less trouble in operation.

Another novel feature of the design is the elimination of the basement in the generator room. As the plant is laid out, the operating floor is on two levels, one at the base of the generator, and the other at the elevation of the turbine, so that practically all the equipment is in view of the operator at all times.



Close Up View of the Largest Water Driven Power House on the Pacific Coast Which the Southern California Edison Company Brought Into Service Oct. 11th, 1923. The Long Shot View Shows the "Electric Giant" as It Is Seen Looking Down the Grand Canyon of the San Joaquin River in the Fresno County of California.

The switching station is 195 ft. in width by 430 ft. in length, and consists of a series of concrete benches excavated on the slope of the mountain, there being a difference in elevation of 46 ft. between the upper and lower benches. These benches support the oil switches, disconnecting switches, frames and insulated piers for carrying the bus structure.

The Penstocks.—The penstocks for the turbines are made entirely of lap welded pipe, varying in diameter from ½ ft. to 6 ft., the penstock valves at the bottom of these lines being the needle type valve. At the upper end of the penstocks are installed 7½ ft. diameter butterfly valves, arranged for control from the powerhouse.

At the upper end of the penstocks there is installed a manifold of special design, which connects the six penstocks of the ultimate installation with an 18-ft. steel pipe, connecting to the tunnel.

At this location there is also installed a surge tank excavated from the solid rock. This surge tank has a shape similar to an hour glass, the largest portion being about 75 ft. in diameter.

The Tunnel.—The 21-ft. diameter tunnel leading from the intake at the diversion dam to the penstocks is 30,000 ft. in length. This has been excavated on a slope of 3 ft. per 1,000, having a carrying capacity of 3,000 second feet. This tunnel, excavated from the solid granite, is unlined throughout, excepting for two or three short stretches where bad ground was encountered. The concrete lining in these places is placed by pneumatic concrete placing machines, located in the adits to the tunnel. The tunnel was excavated from the intake and outlet and three intermediate adits, the excavation being done by standard gauge, air-operated shovels, which were cut down to operate economically in a 21-ft. bore. The muck was removed by means of combination trolley and storage battery type locomotives. The drills used for blasting were especially designed for this type of tunnel. In March, 1922, a world's record for this size tunnel was made by one of the crews, 476 ft. of progress being achieved during that month. The intake to the tunnel consists of a reinforced concrete structure, 115 ft. in height. The flow of the water into the tunnel is regulated by a 22-ft. diameter circular sluice gate, which was designed by the Edison Company's engineering department.

The Sewage Sludge Problem in United States

Progress Toward Its Solution Outlined in Report of Committee Presented Oct. 10 at Annual Meeting of American Public Health Association

The Committee on Sludge this year brings in a progress report to outline what has been done toward solving the sewage sludge problem in the United States. As the work divides particularly by the organizations handling the investigations, the report is so outlined.

Milwaukee Sewerage Commission.—Mr. T. Chalkley Hatton gives the following notes on the Milwaukee work:

The Milwaukee Sewerage Commission appointed a Fellow to the Agricultural College of the University of Wisconsin who has devoted his entire time to the use of sludge in agriculture. Intensive studies have been made of the values of activated sludge in comparison with commercial fertilizers of different mixtures. Plantings were made of corn, soy beans, Sudan grass, tobacco and other crops at the experimental farms of the University of Wisconsin, at Marshfield, Hancock, Codington, Madison and Wauwatosa. To determine the value for grass in golf greens, tests are being made at the Blue Mound, Ozaukee, Lynx and Tripoli Golf Clubs, and the Milwaukee Country Club and the Pine Bluff Country Club. A large number of pot cultures have also been made at the greenhouses of the University of Wisconsin.

The National Fertilizer Association has also been advised of the possible value of activated sludge. Samples have been sent various fertilizer distributors for investigation. The cooperation of the Executive Committee of the Association has been assured in handling and marketing the prepared sludge should it prove as satisfactory as appearances indicate.

Sanitary District of Chicago.—The Sanitary District of Chicago has interested a number of agricultural experiment stations in growing tests. Work is under way on cotton in Mississippi, and on garden plants at the University of Illinois. In the Chicago territory sludge has been distributed to peony and rose growers, truck farmers, cabbage growers and to various individuals. The Lincoln Park, West Side and South Park organizations are trying sludge on lawns and grass plots.

The District has operated a test plot during the growing season, planting corn, beets and beans, with various combinations of fertilizer. Some 45 plots, each 1,100 sq. ft. in area, were planted. The land, while formerly used for truck gardening, had lain idle for over four years. The results in general have been encouraging. A record of weights is being kept, as the vegetables are picked, which will furnish a criterion of the real relative production.

In addition, the District has used sludge in seeding grass, in comparison with sheep manure.

The best price obtained during the year on the sale of carload lots was $9.00 per ton f. o. b. cars for sludge, dried and bagged.

Baltimore.—Mr. Milton J. Ruark, Division Engineer of Sewers, gives the following notes of interest with reference to the sludge handling problem of Baltimore: During the year 1922, the total production of sludge was about 5,400 tons on a dry basis. This is the greatest rate of production in any year since 1918, when the output was somewhat greater. During the 1922, about 5,500 tons on a dry basis was handled, a portion of this being heat dried sludge from the drying plant and the remainder air dried sludge taken by local farmers. For more than a year no charge has been made for air dried sludge. This season farmers have taken the sludge as often as it is produced by the sand beds, so that the drying plant has not been operated for several months.

At the present time, no income is being realized from the sale of sludge. The city has provided means to load the farmers' trucks from a trestle by dump cars direct from the sand beds, or by a derrick from the storage pile. As a rule the farmer arranges to handle sludge only when the city is operating one of the loading devices. Occasionally a farmer loads his own truck. The sludge is all used within a radius of about 4 miles, whenever possible, the farmers hauling it

directly to the field, where it is spread and plowed under. Sometimes it is placed in piles or composted with manure for spreading on the fields at a later date. The farming community served is almost entirely composed of truck farmers. The sludge is therefore used to a large extent for such plants as cabbage, spinach, potatoes, string beans and tomatoes. It is used to some extent on corn, and to a very limited extent on grass. The amount of horse and cow manure available has decreased markedly in the last few years with the result that its cost has reached a point where farmers are seeking other materials for fertilizer. While it is evident that the farmers in the vicinity of the Baltimore plant believe the sludge is worth the handling, the city officials have desired to satisfy themselves of the real value of the sludge in agriculture. In cooperation with the Agriculture Experiment Station of Baltimore, a series of experiments have been outlined to extend over some 4 or 5 years. 9 acres have been laid out in 6 sections of 1½ acres each, each section being divided into 6 plots of ¼ acre each. The whole of each section has been treated with one of the following fertilizers: Liquid digested sludge, air dried sand bed sludge, commercial fertilizer, commercial fertilizer and dry sludge and manure. As a control, one plot has been given no treatment. One half of each section then was treated with lime in a manner to cover half of each plot. In one plot of each section will then be planted some crop, and likewise with each of the other plots, so that in any year some crop will be growing on ground treated with all of the six fertilizers, both with and without lime. Rotation of crops will probably be introduced, but the ground will receive the same fertilizer year after year. A special experiment with alum treated sludge will also be started on other ground.

At the date of Sept. 15, the farm was already growing late potatoes, beans and fall cabbage. It is proposed to plant spinach and grass seed in the fall and next spring to add another crop, probably tomatoes, making a total of six different crops.

The preparation of air dried sludge for the year 1922 cost $.666 per ton.

Rochester.—Mr. John F. Skinner reports that at the Irondequoit plant of the City of Rochester, N. Y., about 10,600 cu. yd. were prepared for market in 1922 by air drying. This sludge was sold at an average price of $0.75 per load of 2 cu. yd. to farmers, delivery being made by a tipple to the teams and auto trucks. When shoveled from storage only $0.50 was received by the city. The sludge is largely used in the top dressings of the orchards for a distance of 7 miles around the plant.

Houston.—From Houston, Mr. J. C. McVea reports that during the calendar year 1922, 4 cars of sludge were sold. The buyers preferred sludge which had not been pulverized. Five tons were delivered to local truck growers and others for use near Houston. The results obtained by various gardeners and by the Houston City Park Superintendent on the municipal golf course and in the parks have been very gratifying. Growing experiments were made on a small scale with turnips, tomatoes, lettuce and radishes, in which the value of the sludge as a fertilizer was demonstrated. In particular, the turnips

Table I.—Percentage Increase Over Unfertilized Turnips.

	Weight in Ounces			Per Cent Increase			
No.	Total	Roots	Tops	Total	Roots	Tops	How Fertilized
1	11	3	8	0	0	0	Not fertilized
2	18	7	11	64	133	38	Blood
3	41	14	27	273	367	237	Nitrate Soda
4	63	28	35	473	832	338	Activated Sludge
5	59	31	28	436	932	250	Activated Sludge and Phosphoric Acid

Table II.—Production Data and Analysis of Sludge Reported for 1922.

City	Baltimore	Rochester	Chicago	Houston
Plant	Hydrolytic	Imhoff	Activated	Activated
Production in 1922, net tons dry weight	5,421	6,440	400*	70()
Air dried-cu. yd.	------	10,600	-------	-------
Analysis on dry basis		Per cent		
Nitrogen				
Average 2.45		2.00	5.0	4.6
Maximum		2.17	5.6	----
Minimum		1.95	4.3	----
Phosphoric Acid 0.52		0.8	2 to 4	1.9

*Approximate amount on 12 months 1922-23.
(Produced for experimental use and sold as fertilizer.
)Estimated production would be 1720 tons, if prepared.

were vastly improved, the ones fertilized with sludge being the only ones edible, being sound and sweet, the others being dry and fibrous. The results on the turnips are given by Table I.

Preparation of Sludge.—In the preparation of the sludge, development of methods and apparatus is still progressing with very encouraging results.

At Milwaukee, the tests have been concluded on sludge handling, with the conclusion that provision should be made for the use of acid and heat with the Oliver filter.

At the Des Plaines River Sewage Treatment Plant of the Sanitary District of Chicago dewatering has proceeded using alum, or acid, with and without heat. At first only a Worthington bag platen press and a Simplex plate press were available. In August tests were begun on a novel hydraulically operated bag press, designed by Berrigan, with direct squeeze, which has the advantage of taking care of any desired thickness from ¼ inch upwards. The press cake (in moisture content from 73 to 83 per cent moisture) is dried in a rotary direct-indirect dryer. A pulverizer is required to crush the balls which occur, though not in large number.

At the Calumet Sewage Treatment Works of the Sanitary District, dewatering has proceeded using alum or acid on the Oliver filter installed. This filter is the largest size built, the drum being 11 ft. 6 in. diameter with a face 14 ft. wide. Space has been left in the house for a Basco-ter-Meer centrifugal. A dryer similar to the one at the Des Plaines River Sewage Treatment Works operates on the sludge cake intermittently.

At the testing station, operated jointly by the Sanitary District and the Corn Products Refining Company at Argo, tests have been run on plate filters and a single wheel American rotary filter. Alum has proved more successful as a coagulent than acid.

At Houston, the cost of preparing the sludge has not yet developed to a point where definite costs can be given. Several methods have been tried. At present the use of sulphur dioxide gas is being tried to prepare the sludge for pressing. There has been no complaint of odor from sludge handling or the preparation of the sludge.

The nitrogen recovery in activated sludge at the various points of operation is as follows:

Activated Sludge.

Recovery of Nitrogen and Phosphoric Acid.
Nitrogen as N; Phosphoric Acid as P_2O_5.
Per cent dry basis.

Location	N	P_2O_5
Sanitary District of Chicago		
Argo	7 to 8	6 to 7
Tannery	3.0	
Packingtown	4.2	2.7
Des Plaines R. S. T. W.	4.5 to 5.5	2 to 4
Calumet S. T. W.	4.2 to 4.4	
Houston	4.6	1.9
Milwaukee	6.0	2.3

By the alkaline permanganate method the total available ammonia in the Milwaukee sludge is 4.61 per cent, 63 per cent of the total ammonia.

The Committee on Sludge of the American Public Health Association consists of Langdon Pearse, Chairman, T. Chalkley Hatton, C. H. Hurd, Earle B. Phelps and W. L. Stevenson.

Concrete Tile Experiments in Alkalin Soil

Fifteen hundred feet of experimental concrete tile has been made up by University of Minnesota men who are cooperating with the U. S. Department of Agriculture and the Minnesota State Department of Drainage for the purpose of developing a tile that will endure in various types of alkalin soil. The tile has given satisfactory results under severe laboratory tests conducted at University Farm, St. Paul, by D. G. Miller, engineer who represents the U. S. Department and is in charge of the work.

Some of the tile has already been installed, or soon will be, near Marshall, Lyon county, Minn.; at Bitter Medicine Lake, 20 miles from Watertown, S. Dak., a lake shore so strongly impregnated with alkali that scarcely anything will grow there; and in alkalin soil near Enderlin, N. Dak. Some of the tile, which will be used to check up the field experiments mentioned, has been laid on the university's farm, St. Paul.

Sections of the tile will be dug up every year for inspection and study. This is the first of a series of tests under field conditions which the three cooperators, university, state, and government, are planning to make in the northwest.

Water Works Additions in New England

New Works Now Under Way Described in Paper Presented Sept. 19 at Annual Convention of New England Water Works Association

By ALLEN HAZEN
Consulting Engineer, New York City

The Development at New Britain, Conn.—Several years ago a plan for development of the water supply system was worked out on a scale sufficient to serve the city for many years. When carried out this will result in the complete development of the present water resources.

The plan is unusual in that no good storage site was found to which most of the water would come in a natural way. The plan is to build a large impounding reservoir on an excellent site but with a very small catchment area, and to take the major part of the flood flows from the other areas to it. In this way a practicable scheme was worked out for complete development of these valuable resources. The cost of carrying out even the first installment of this program will be large, and postponement as far as it can be done with safety will make the financial arrangements easier.

In making borings for dam sites, great masses of sand were found in one of the valleys. To build a dam on this sand was impracticable, but it was thought that it might be possible to develop a ground water supply in this location, taking advantage of the natural underground storage in this valley. In this way an addition to the water available in dry times could be obtained that would permit the construction of the main storage reservoir to be postponed for several years.

Some of the works built in this way could be arranged to be part of the permanent construction, but any of it that it might be necessary to discard in future development would have been more than made good in the saving in interest on the cost of the delayed construction.

Accordingly, the city authorized the construction of an underground supply of this kind, and the work has been carried out and the supply tested during the present season. There are 20 wells, 8 in. in diameter, averaging 40 to 45 feet. The position of the wells was determined, first, by very numerous test borings; and second, during construction by pulling up and discarding all wells that did not show favorable results in actual tests. Every one of the 20 wells is therefore believed to be a good one. The Cook strainers are 15 ft. long, 8 in. in diameter, and the slots for the most part are 0.05 in. wide, but some of them are 0.06 in. The slot opening was made as great as the sand would stand. In a few instances, sand was encountered so fine that it continued to come into the wells in quantity, and these wells were abandoned and the strainers pulled. In most cases a considerable quantity of sand entered the well in the early testing and was pumped out until a condition of stability was obtained.

In this testing, an arrangement was used for giving violent back-and-forth agitation in connection with the pumping, and this was continued until the water came continuously clear and until all fine sand had been removed from the bottom of the well.

The water from these wells is taken into a caisson well, which is covered, 50 ft. in diameter and 30 ft. deep, which itself on test yielded about 1 mgd. The use of this well is to insure the entire absence of sand and air in the water taken by the pump.

In driving the wells a 12 in. casing was first driven to the full depth. The strainer and permanent well pipe were placed in it and the 12 in. pipe was then drawn. Sometimes coarse sand was placed in the space before drawing the 12 in. pipe. Independent 4 in. suctions are used in each well, and the connections are arranged so that each suction can be easily removed and the well tested and cleaned, and this can be done with the well shut off and with the rest of the plant in service. A concrete box is built about the head of each well, giving convenient access to facilitate these operations and to exclude surface water. The main suction pipe, laid well below the ground level is of cast iron pipe with bell joints, caulked

with lead wool by a pneumatic hammer, and made absolutely tight under air pressure. This is laid with a very slight upgrade to a summit after passing which it drops almost to the bottom of the caisson well, acting as a siphon when the water level is depressed. An air pump attached to the highest point keeps it clear of air.

The water is pumped by a horizontal duplex driven by a 150 h. p. Diesel engine. It has a capacity of 3 mdg. against a head of 250 ft.

The plant has been able to operate continuously at capacity during the present very dry season, and its use has perhaps prevented a water shortage in New Britain. The water is clear, cool, soft and free from iron.

The cost of the new works has been very moderate. The bills are not yet all paid. Present indications are that including land and all expenses it will not exceed $175,000.

Mr. Joseph D. Williams is city engineer and has immediate charge of the construction work.

Enlargement of Filter Plant at Springfield, Mass.—In the 14 years since the Springfield Little River System was put in service the water business in Springfield has almost doubled. The output has not increased in quite that ratio because in the beginning the system was only partially metered, and during the early years with metering there was an actual reduction in output.

Springfield has grown more rapidly and continuously than any other city in Massachusetts. In addition, the policy has been followed of supplying water to neighboring communities at wholesale.

The underlying thought in doing this was that it would cost these communities at least twice as much to get corresponding service for themselves as it would cost the city of Springfield to supply them.

It would be fair to divide this advantage equally. With this done a price could be fixed that would yield Springfield a profit of 50 per cent on all the business done, and the towns would still be getting water 25 per cent cheaper than they could otherwise get it. These figures are not precise but they illustrate clearly the controlling thought in the business.

If the cost of the service is estimated, taking into account all the costs that there are, including interest and depreciation, and basing the rate on the actual output rather than on the rated capacity, and 50 per cent is added, the estimate of the fair price for these takers is reached. No water supply system will suffer by taking additional business that carries a 50 per cent profit.

This general policy has been followed and has resulted in substantial additions to the drafts and to the required capacity.

A water works system consists of many parts and these parts do not all come to the limit of their capacity at exactly the same time. This is fortunate for its permits the additions to be built in installments spread over a term of years.

In this case, the Little River runoff has turned out to be greater than expected and as the storage was originally provided on a liberal scale, the source will safely carry something over 15 million gallons originally assumed as the capacity of the first installment. With complete development about three times this quantity will be obtained.

The pipe lines, built of lock bar steel, with high coefficients, will carry somewhat more water than was estimated in advance for riveted steel pipe and will therefore serve a few years longer.

The filters need enlarging first. The water, which, in dry times, is mainly drawn from the Borden Brook reservoir on a tributary, is rather more difficult to treat than was anticipated before the works were built. There has been a much larger load of organic matter in it to be removed, and this has made chemical treatment necessary. Coagulation has been employed, and the load upon the filters has been correspondingly greater.

Notwithstanding the greater load upon the purification works, the present plant has turned out water of the highest quality uninterruptedly for the whole period of its use, and the operating costs, notwithstanding some bothersome conditions, have been on a moderate scale, that has been seldom reached in water purification plants in this country.

The present plant consists of a coagulating basin holding 40 million gallons, and three acres of covered sand filters, and the present rate of output is frequently in excess of the 15 million gallons per day for which the plant was built.

Doubling the capacity of the filter

plant is thus the first logical step in enlarging the plant, and this is now being undertaken.

In doing this the equipment for applying and mixing the coagulant with the water will be improved. Baffles are to be built in the very large coagulating basin which was fortunately a part of the original plant and the sand filters are to be duplicated.

Before deciding to duplicate the present plant, several alternate arrangements were considered. Among these may be mentioned placing scrubbers in advance of the sand filters to lighten the load upon them. This will not be done because present and prospective operating costs are so moderate that it would never be possible to save from them amounts to compensate for the cost of the scrubbers. With the local water and with the chemical treatment that has been employed and that has been found satisfactory, it is not thought that satisfactory purification of the water after treatment by mechanical filters would be possible. If such filters were used a continuous and heavier dose of coagulant would be essential and the operating cost correspondingly increased.

The present plant has produced water of the highest quality and with a low operating cost, and it was not apparent that any more advantageous arrangements could be made in extending it.

It is also taken into account that in the near future a very large storage reservoir will be built upon the main stream and that with the storage of the whole supply in this reservoir a considerable improvement in average quality of water entering the plant may be expected.

The present average color of the water entering the plant is about 37. This will be reduced to a much lower amount after the large proposed Cobble Mountain reservoir is in use. Fifteen years ago, before the plant was built, it was assumed that when Cobble Mountain reservoir was built and complete storage obtained that no further use of coagulant would be necessary. With present ideas with regard to color and color removal, this view must be modified, but it still appears probable that the plant with sand filters of full efficiency may be operated without coagulant for a considerable and increasing proportion of the time in the future.

Mr. E. E. Lochridge is chief engineer of the Springfield Water Works and has supervision of the construction.

New Filters for Providence, R. I.—A general description of the Providence work has already been presented by the chief engineer, Frank E. Winsor, in Volume 36, p. 323, of the Journal of the New England Water Works Association. What I shall say relates only to the filters which are proposed.

The water will be obtained from a storage reservoir that will be large in size and the water before filtering is expected to be of good quality. On the other hand the color records of the last seven years have indicated a distinctly higher color of the river water as it flows than was anticipated in the earlier studies. Allowing for such decolorization in the storage reservoir as that to be expected, it appears probable that there will be color, above allowable limits, in the reservoir water for periods the length and frequency of which cannot be closely estimated. The filters must therefore be capable of dealing adequately with considerable amounts of color as well as with the tastes and odors and other impurities to be expected in a reservoir water. The color to be dealt with on present evidence will be higher at Providence than at Springfield.

The question of whether to use sand or mechanical filters has been studied at considerable length. The higher color of the raw water was one important element in the decision to use mechanical filters; another was the unusual difficulty of the site. Several sites for sand filters were studied. The material in each case consisted of various grades filled with boulders, some of them weighing many tons. Excavating such material and bringing it to a uniform foundation grade and making the bottom watertight presented unusual difficulties and put an added burden on the construction of sand filters.

The water is unusually soft and it was felt that the use of mechanical filters with only a relatively short coagulation period would be likely to result in red water troubles, to the corrosion of the iron and lead service pipes, and to supplementary precipi-

tation of hydrate of alumina in the distribution and service pipes.

The best means of avoiding these conditions at present available seems to be to use a very large coagulating basin capacity. The chemists have been working for many years on some means of accelerating the reactions, but thus far practical experience supports the idea that a large basin is the most efficient means of securing a reasonably stable and quiet water.

A valley has been found where such a basin could be constructed in connection with the Providence filters. This will hold more than a day's supply at the ultimate rate possible from this source and several days' supply at the rates of early years. The adopted plan, therefore, is to give the water chemical treatment, followed by passage through a very large coagulating basin thoroughly baffled, thence passing to mechanical filters.

In the design of the mechanical filters, there will be a number of novel features to adapt them to the conditions to be anticipated in this case.

Preliminary studies have been made for types of filters, combining as far as possible the advantages of both sand filters and mechanical filters, but some of these ideas may require further development before they can be safely applied in so large a plant.

Aeration of the water both before and after filtration is proposed to reduce tastes and odors and also to remove carbonic acid and thus to make the water less active in the pipes.

The Providence water now supplied has been somewhat active. Corrosion of lead pipes and fear of lead poisoning have been much discussed. Lime has been used to reduce this tendency for several years. This phase of the matter is most important and every effort will be made to turn out a water from the new works that is satisfactory in all respects and that is reasonably quiet in the pipes.

The construction of the new filters will be in charge of Mr. Winsor and his assistants.

Water Works of Poughkeepsie and Albany, N. Y.—I am now going slightly beyond the boundaries of New England to say a few words about plants of interest, operating under very different conditions. Poughkeepsie and Albany both take water from the highly polluted Hudson River, and it must be most carefully filtered to remove its disease-producing qualities. This is an entirely different problem from those presented in the plants previously mentioned. In both cases gravity supplies are possible, and will no doubt be ultimately used, but in the meantime, the filter plants must be kept up to standard.

The Hudson River is so highly polluted that it is questionable whether single filtration of any type is capable of producing water meeting present exacting standards with a proper factor of safety. At any rate double filtration has been used at both of these plants for some years, and is now regarded as a necessary part of the procedure.

The water first receives chemical treatment, then goes through coagulating basins and passes to scrubbers, which are mechanical filters with only a little of the equipment omitted, and then passes to sand filters. The sand filters in each case represent the earlier plant and the scrubbers are more recent additions.

At Poughkeepsie the scrubbers were added as a war measure when increased capacity was urgently needed and when the old sand filters were having trouble in maintaining service. Since they have been used it has only been necessary to clean the sand filters about once a year. The scrubbers do the heavy end of the work and the sand filters finish it and remove whatever materials come through the scrubbers, including tastes and odors and at times a certain amount of hydrate of alumina. The water is aerated once only between the two sets of filters.

The Poughkeepsie plant is ample in capacity at every point for present output and has worked easily with the production of water of such uniformly good quality that the residents of Poughkeepsie are not interested at present in changing the source of supply.

During the present year a new 5 million gallon covered reservoir is being built to give 20 lb. needed additional pressure and to permit water to be delivered in the city of the same excellent quality as that leaving the filters.

The old open reservoir in which objectionable algae growths sometimes took place will be held as an emergency reserve to be connected with the system only in case of conflagration. A new loop of 24 in. pipe extending all the way from the source of supply around the business district

of the city to the new reservoir has been provided and with a few main feeders will give ample distributing capacity for years to come.

At Albany a somewhat similar general filtering arrangement was installed earlier, and has for years made operation possible, but can be improved.

One of the undesirable conditions has been that the water was pumped from the coagulating basin to the scrubbers. This has broken up the floc and has made efficient operation impossible. The filter sand in the scrubbers was too coarse and had become very dirty. The scrubbers were demoralized; floc passed entirely through them, and clogged the sand filters rapidly until they could not be adequately cleaned, and it has been thought necessary to bypass some of the partially treated water to the city.

Chlorine treatment has saved, or nearly saved, the situation from a hygienic standpoint, but the results have not been satisfactory in other respects.

It is proposed to reconstruct the scrubbers, bringing them back to standard condition; to build a new covered coagulating basin at higher level so that the water will flow from it to the scrubbers by gravity, slowly and without agitation, and to use the present coagulating basin as an intermediate receiving basin between the two sets of filters. Other changes will be needed, and when these are carried out, it is hoped that operating conditions may be brought fully up to the highest standard and maintained as long as the present source of supply is used.

It is to be noted that tests during the recent period of very low flow in the Hudson River have shown at Albany a much heavier load of fresh putrescible organic matter from sewage in the water than has been found at Poughkeepsie and the water is correspondingly more difficult to treat at such times.

It is thought at Albany that even though a gravity supply, for which there are excellent opportunities, should be introduced in a few years, the need of better water was so urgent that the present filter plant should be put in order in any event.

Mr. F. A. Raven is commissioner of public works at Albany and Mr. Thomas F. Lawlor, superintendent of public works, at Poughkeepsie.

Engineering Employment Shows Slight Recession

Employment conditions affecting engineers reflect considerable irregularity with special divergencies between the trends in different industries and engineering endeavors is reported by the Employment Department of the American Association of Engineers. Numerous inquiries are being received from men from all sections of the country, desiring to make new affiliations, or who report the completion of their work, indicating that a slight recession in employment is apparent. In September there was practically no unemployment among engineers, but during October some unemployment was noticed in different quarters. Engineering employment from now on will continue to slacken from the normal trend of conditions, and no apparent advance will be noticed until about after February 15th.

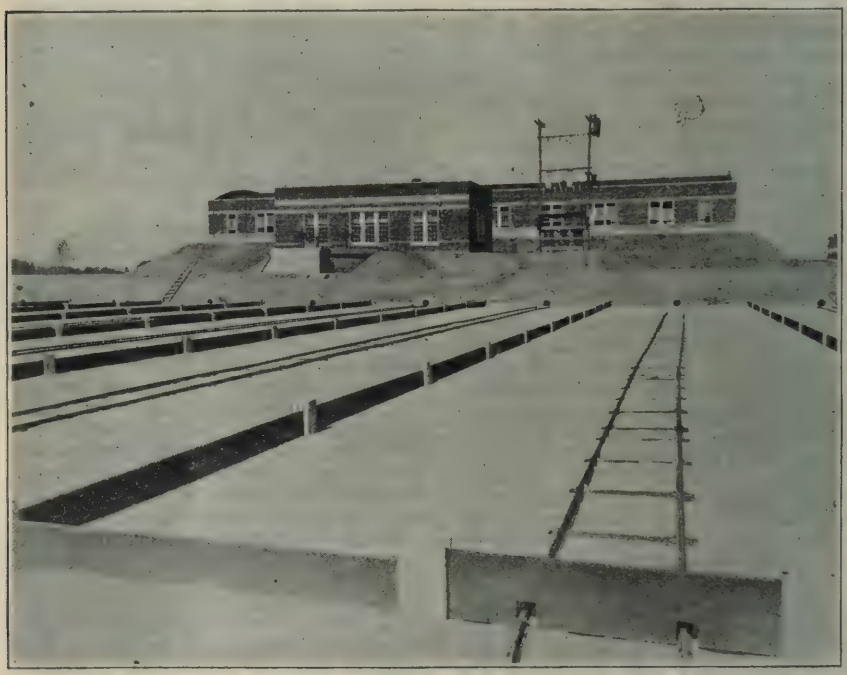
The engineers mostly affected at this time are civil engineers particularly those on construction work including superintendents, instrumentmen, and general field engineers also engineers with oil companies in the mid-continent field. There is practically no demand for men on irrigation, drainage, hydraulic or construction work at this time. Manufacturing and industrial companies have reduced their technical staff although a few lines continue activity, such as machine tools, railway equipment and automobile manufacturers. The greatest demand at this time is for architectural engineers and draftsmen. A fair demand is evident for highway engineers, especially designers on plans and bridges. The railroad field for engineers is practically dormant.

Positions for engineers on the Pacific Coast and Southern California are fair. In the Northwest, conditions are tightening up with little work for engineers in the states of Washington, Montana and Idaho. The central states are fair for employment. The Eastern section is not very desirable for employment; more men looking for positions open. The South is starting considerable activity with a good demand for engineers of the junior grade. The greatest unemployment of engineers at the present time is in the Northwest and in the Eastern section of the country.

The New Sewage Disposal Works of Lincoln, Neb.

Pumping Station, Sludge Separating and Digesting Tanks, Dosing Tanks, Sprinkling Filters and Sludge Beds

A sewage disposal plant having many interesting features has been completed recently at Lincoln, Neb. The plant was built for the Lancaster County Sanitary District No. 1, serving the city of Lincoln and the suburbs Havelock, University Place, Bethany and College View. The total population of the district at the present time is 70,000, of which 50,000 will be served by the disposal plant. The plant will ultimately take care of the sewage of 80,000 people.



New Sewage Disposal Plant of Lincoln, Neb. Sludge Beds in Foreground.

Before the erection of the plant the raw sewage was discharged into Salt Creek and serious nuisance had resulted from this at times of low flow in the creek. In 1920 Alvord, Burdick & Howson, Consulting Engineers, Chicago, were engaged to make an investigation and a preliminary report on conditions. They recommended that a sprinkling filter plant be constructed. Construction was started in June, 1922, and the plant was completed last month.

The plant is located near Salt Creek, at a point well isolated from habitation. The clear effluent is discharged into the creek. The sewage handled by the plant is purely domestic and is collected by a system of 125 miles of sanitary sewers from which storm water is rigidly excluded. The maximum age of the sewage at the time it reaches the plant is 5 hours. During normal times diluting water is available in the amount of 2 to 3 cu. ft. per second per thousand population. The minimum flow is less than 1 cu. ft. per second per thousand of population.

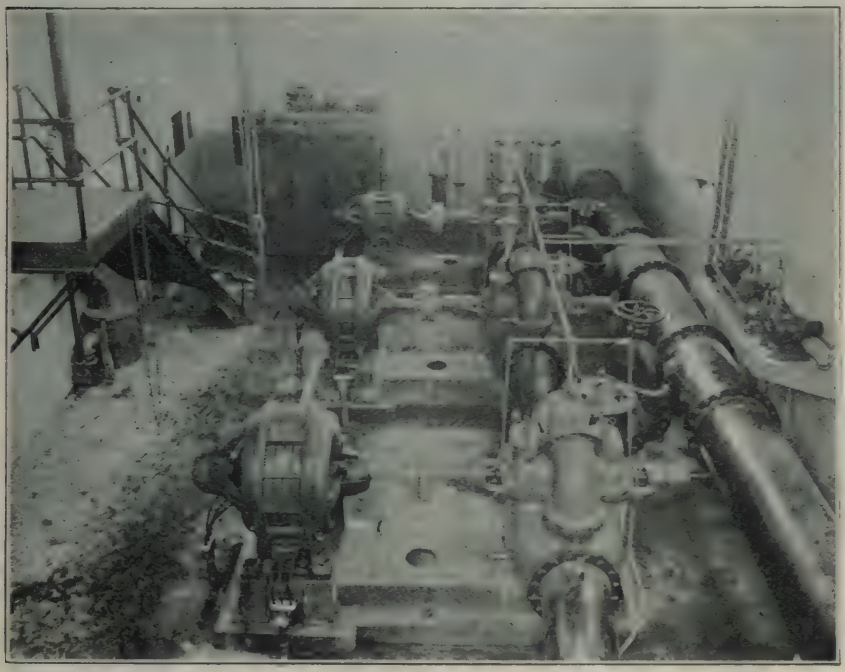
Design Data of Plant.—The principal design data of the plant follows:

Principal Design Data, Lincoln, Neb., Sewage Disposal Plant.

	Condition No. 1 Year 1922	Condition No. 2 Year 1923
Population of District	70,000	100,000
Population served	50,000	80,000
Sewage flow M. G. D.	4.0	6.5
Capacity of Present Outlet Sewer	32 c. f. s.	32 c. f. s.
Capacity of Pumps (each unit)		
No. 1	4 M. G. D.	4 M. G. D.
No. 2	6 M. G. D.	6 M. G. D.
No. 3	8 M. G. D.	8 M. G. D.
Velocity through screens (ft./sec.)		
Ave.	.745	.927
Max.	.833	1.094
Tanks:		
Gross Retention Period hrs.	3.08 hrs.	1.89 hrs.
Net allowing for 9 ft. of sediment and 3 ft. of scum	2.33 hrs.	1.43 hrs.
Digestion tanks cu. ft. per capita (Gross)	1.25	.78
Dosing Tanks:		
Number	4	4
Minutes to fill (Time between doses)	30	30
Minutes to discharge	10	18
Filters:		
Rate per acre M. G. D.	1.56	2.5
Depth, ft.	6.0	6.0
Sludge Beds:		
Depth, in.	(Ave.) 11	(Ave.) 11
Area, sq. ft. per capita	.8	.5

Pumping Station.—The sewage is brought to the plant in a 54 in. segmental block intercepting sewer. This sewer had to be laid at so low an elevation that it was necessary to pump the sewage through the plant. The pumping is done by three pumps, made by the Aurora Pump & Manufacturing Co., Aurora, Ill., of 4, 6 and 8 million gallons capacity respectively. The smallest pump will handle the normal flow, and the combined capacity of all three exceeds the capacity of the intercepting sewer. The pumps under test showed efficiencies of 79.2 per cent, 84.7 per cent and 79 per cent for the pumps under rated conditions —exceptionally high pump efficiencies for sewage work.

Disposal Plant.—The raw sewage flows through inclined bar screens made of ¼ in. by 2½ in. bars on 2 in. centers, inclined at 45 deg. slope to a suction channel under the pump room floor. The suctions of the pumps drop vertically into the suction well. The pumps discharge through a cast iron main, provided with a Venturi meter, to the sludge separating tanks. There are six of these tanks, each 27 ft. by 27 ft., with 14 ft. vertical sides and inclined hoppers, with slopes of ap-



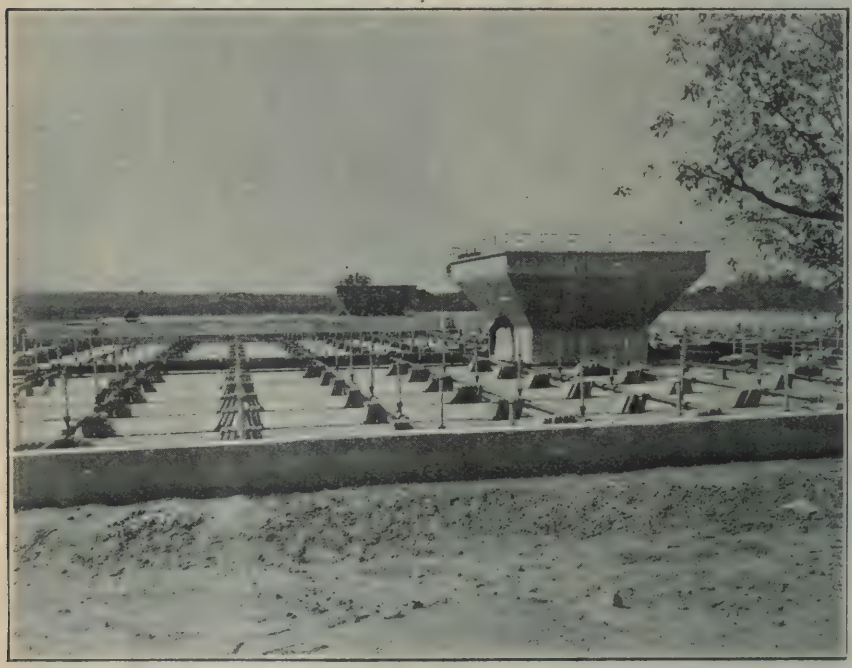
The Pumping Installation at New Sewage Disposal Plant of Lincoln, Neb.

proximately 45 deg. These tanks are so designed that all six may be used as primary separating tanks, or changed to four primary and two secondary in series.

Immediately adjoining the sludge separating tanks are six sludge digestion tanks. The floating scum is drawn from the settling tanks to the digesting over weirs. The sludge is drawn from the hoppers by hydraulic head through pipes. Provision has been made for the withdrawal of liquor from intermediate depths between sludge and scum in the digestion tanks and for its return by gravity to the clear well, and thence passing through the plant again with the sewage. From the tanks the settling sewage goes to the dosing tanks serving the stone beds. These dosing tanks are of taper design to provide equal distribution of the sewage over the stone beds.

The stone beds are approximately 2¾ acres in area. They are 6 ft. deep, the lower 5 ft. being ¾ in. to 1½ in. stone and the top ½ in. to 1 in. stone. The local stone was not suitable for this purpose, so a quartzite from South Dakota was used.

Distribution System of Filters.—The piping system consists of 6 in. to 24 in. cast iron pipe supported on piers at the stone bed. The risers are of 3 in. galvanized iron. The nozzles are of the Worcester circular lock spindle type, with 16 ft. spacing on the equilateral triangle plan. No underdrainage other than that given by the coarse stone is provided. The filter is underdrained through channels built in the concrete on 14 ft. centers. These channels are covered by concrete slabs. The floor has a pitch of 1 in. per foot toward the channels.

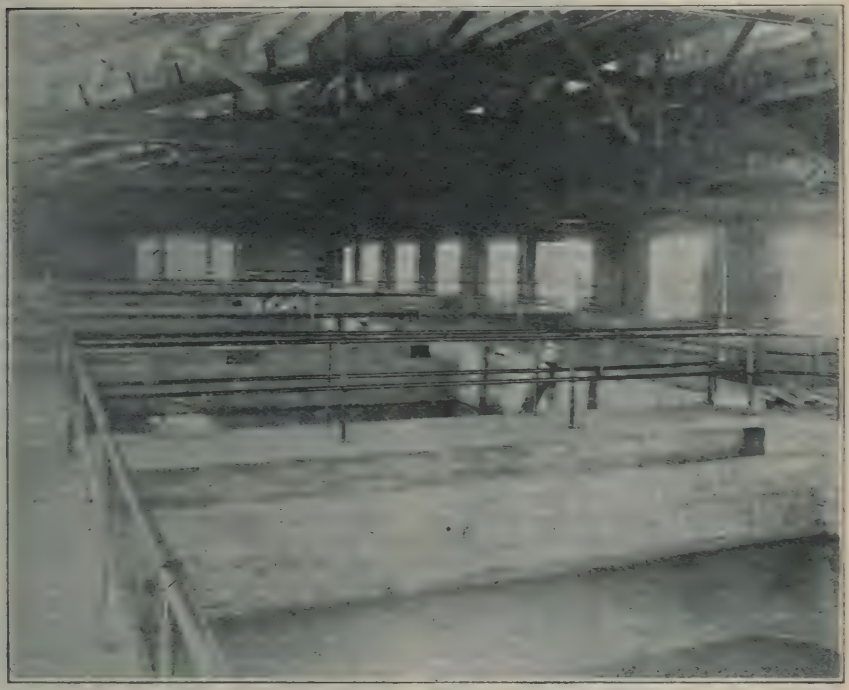


The Sprinkling Filters at Sewage Disposal Plant of Lincoln, Neb.

Sludge Beds.—The sludge beds provide an area of 0.8 sq. ft. per capita. They are 12 in. in depth, of which 10 in. is bank run gravel and 2 in. is fine sand top. They are underdrained by 6 in. of vitrified tile drain. The sludge will be removed in cars running on a light industrial track.

The total cost of the plant was approximately $350,000. The construction period required was about 15 months. A. Phelps & Sons, Knoxville,

Ia., were the contractors. Alvord, Burdick & Howson, Chicago, were the engineers in charge of plans, specifications and general supervision of construction. Grant, Fulton & Letton, Lincoln, Neb., were associate engineers in direct charge of construction.



Interior View of Lincoln, Neb., Sewage Disposal Plant.

Water Supplies of American Cities.—A survey of 83 cities or 100,000 population and over, made in 1921 by the committee on municipal health department practice of the American Public Health Association, showed that the public supplies of the 83 cities were for the most part derived from surface sources and were usually treated by chlorination as a final method, although the intermediate treatment processes varies considerably in different places. Only 9 cities, serving 4 per cent of the total population, used water without some form of treatment, 8 of these supplies coming from wells and the other from mountain streams. In 11 of the cities the water supply was owned by a private company, in 3 by a Metropolitan Board, and in the remaining 69 by the municipality itself. Practically all of the 83 cities either had a laboratory at the water plant or other arrangements for laboratory examinations. Data available for 54 cities whose treatment plants were under technical control indicated that a laboratory was located at the plant in all but 9 cases.

Short Course for Texas Water Works Operators

The Waco City Water Board, City Health Department and Baylor University, with the State Health Department and the Texas and Southwest Water Work Associations co-operating, will conduct a free short course of practical instruction for water works attendants and filter plant operators at Waco, during the week beginning Jan. 21st, 1924. Anyone interested may attend. There is no charge for tuition or laboratory fees and no expense except that actually incurred in making the trip. Further information may be obtained from Dr. W. T. Gooch, Baylor University, Waco, Tex., or to Mr. V. M. Ehlers, State Sanitary Engineer, Austin, Tex.

Adopting Proper Schedule of Water Rates

Considerations in Deciding on Charges for Water Discussed in City Manager Magazine

By W. W. RICH
City Manager, Alexandria, Va.

In discussing the rate question in connection with a modern water works system, there are a number of features that must be taken into account, and it would be well to adopt a classification for this discussion. In general, the physical features of a water works system may be broadly divided into the following divisions: Pumping station, water mains, service connections, and meter services. In addition to the above classifications, we have the department for taking care of the revenue collections and the department for interest and retirement of bonds. The last two classifications are very important, but unfortunately they are usually the ones that get the least attention. This is especially true where a city is governed by the aldermanic system, as there is a tendency to make a political football out of the water works department and at each change of the administration there is generally a change in all of the important offices in the department. As a consequence there is no fixed responsibility or authority, the revenue collections are neglected, the rates are not adjusted to meet conditions, and in many instances the funds for retiring bonds are lost sight of entirely. In order to make a success of a municipally owned water works, the business must be conducted in the same manner as if it were privately owned. There must be some one person responsible for the system and the authority must be undivided.

Budget System Essential.—To operate a municipally owned water works system successfully, a budget system must be adopted and strictly adhered to. The costs of operation and maintenance must be carefully kept, in order to determine just and equitable rates. The following classification, briefly outlined, is adequate for most water plants: The water department is divided into departmental divisions consisting of pumping station, water mains, service connections, meter services, revenue collection, and interest and retirement of bonds. These divisions are themselves divided into expense and capital outlay accounts according to the budget classification. Expense comprises all items of expenditure necessarily incurred for current administration, operation, and maintenance of the several departmental divisions; those which the funds are reimbursed; and those for materials and equipment in the nature of renewals or replacements, which do not add to the capital assets of the corporation. Capital outlay includes all expenditures which increase the capital assets of the corporation. This includes land and land improvement, buildings and public improvements, teaming equipment, motor vehicles, furniture and fixtures, and any other equipment which may be necessary and useful in the operation of the plant, and which may be repeatedly used without appreciable impairment of its physical condition and having a calculable period of service.

Leaks Are Unnecessary Burdens.—The need for operating a water plant efficiently and accurately accounting for the expenditure of the funds is obviously very great at the present time owing to the high cost of everything entering into the operation and maintenance of the system. However, in many cases the rates have remained the same, or if they have been raised at all, they have not been raised sufficiently to offset the greatly increased cost. Because of these increased costs it is more necessary than ever that the great wastage that occurs in practically all cities be stopped, as it is not fair to the public to burden them with paying for water wasted through negligence.

A large portion of the water that leaves the pumping station never does any useful work; some of it is wasted through the ground owing to poor construction of the mains and service connections; some is wasted through faulty plumbing, and some is wasted through carelessness of the consumer where there is no meter. All of this wastage means a great loss to the citizens of the community, for they are the ones that pay for it ultimately, besides reducing the pressure and causing a diminution of the sup-

ply available for fire fighting purposes. In my opinion, too much stress cannot be laid upon the wastage and leakage of water, and as far as the consumer is concerned, the only practical method of stopping excessive waste is to install meters on all services.

All Services Should Be Metered.—The reasons for metering all services are two-fold: First, because it is the only fair and equitable way to sell water; and, second, it is the only practical way to prevent waste by the consumer.

Once a city has started out on a definite program of metering all services, it is confronted with the question of arriving at just rates for the water. Unfortunately, in a great many cases, no study is made of the local conditions to determine what the service actually costs but on the other hand the governing body of the municipality will instruct the water superintendent to write around to a number of neighboring cities to find out what they are charging. Then, without giving the matter any study at all, they will adopt a rate which will be very close to the rate of some city, which, in their opinion, has a plant similar to theirs. The sliding scale is usually adopted, and, in my opinion, the scale usually slides too much.

Rates Should Be Made According to Cost, Not Custom.—Each water plant has problems peculiar to itself and the rates to be applied to any particular plant must be worked out for that plant and cannot be determined by the rates adopted by some other plant, just because the conditions are somewhat similar. Considerable work has been done in recent years along this line, the foremost book being that written by Mr. Allen Hazen entitled "Meter Rates for Water Works," published by John Wiley & Sons, Inc. This book covers the ground very thoroughly and discusses both the minimum rate schedule and the service charge.

The rate adopted for this discussion is that which is based upon the service charge. This rate was adopted by the New England Water Works Association on Nov. 6, 1916. The schedule recognizes the principle of the sliding scale and provides three rates. These rates are not fixed, but are left to be determined for each case as may be necessary to provide the necessary revenue. The quantities of water per annum, per quarter, or per month to which the three rates are applicable are defined and are made uniform by the schedule. In addition a service charge is provided which is for the privilege of having a service, but does not include the use of any water. The service charge is an alternative for the minimum rate and represents a more logical and more just arrangement. Under the service charge a specific amount is collected for the service and meter. This amount is collected regardless of whether any water is drawn or not. If water is drawn it is charged for, and the amount charged for water is added to the amount of the service charge.

Determining the Service Charge.—The service charge is made up of the following items:

First, a sum per annum representing approximately the cost of reading the meters, keeping the records, making out the bills, etc. For meters read quarterly, it is estimated that one dollar per annum is sufficient allowance.

Second, an amount which will represent the approximate value of water which passes a meter without being registered. The amount lost per service will range from nothing to 13 cu. ft. per day for a 5-8 in. meter. On this basis a charge of $2.00 per annum would not be out of the way for most municipalities for a 5-8 in. meter. The charges for the larger meters are proportional to relative capacities.

Third, an amount which will give a reasonable return on the money invested in the service pipe and meter. It is estimated that 10 per cent is a fair allowance for the depreciation in the service pipe and meter and for the interest on the money invested in them.

From the three items above mentioned the service charge applicable to each size of meter may be determined, and adopted as a fixed charge in the schedule.

In computing the rates the first step necessary is to determine the value of the water works in the following main divisions: Pumping station; water mains; water services and meters. Next determine the principal and interest necessary to take care of the bonded indebtedness; and the reserve fund which must be set asids for plant depreciation.

The cost of operation, as determined from the budget classification mentioned previously, added to the

amount required for interest, principal, and depreciation, will determine the amount necessary to be raised per annum to make the plant self supporting. From this amount deduct the amount paid by the City as hydrant rental and for sewer flushing. The result so obtained will be the net amount to be raised from the water consumers on meter rates.

From the records available in all water works, it can readily be determined where all of the water pumped ultimately goes to. For the purposes of this discussion the disposition of the water may be classified as follows: Unavoidable leakage from mains; fire, sewer flushing and undiscovered wastage; leakage from services and under registration of meters; and the water actually sold. Unfortunately, in most instances, a large persentage of the water that leaves the pumping station is never registered as being sold.

Determining the Rate.—In determining the rate, the unit cost of all the water that leaves the pumping station must be ascertained, because the value of the water lost in the distribution on system and the service connections must be charged against them and added to the cost of each. The cost of the water that leaves the pumping station may be determined by dividing the entire cost of operation, interest and principal of bonds, and depreciation, by the total amount of water pumped. The unit cost thus determined will therefore be the unit cost of the water pumped, regardless of the amount wasted.

The total cost of distribution and the total cost of services and meters will, therefore, be the sum of the cost of operation, the interest and principal of bonds, the amount of depreciation and value of water lost.

In computing the unit costs for distribution and services, the amount charged for fire service is a deciding factor. The fair value of the fire service to the community is one thing, but the amount that can actually be realized is another; and as the details of this part of the discussion are rather lengthy, it is not deemed advisable to go into the matter at length at this time. However, after all computations are made, definite rates will be established for the three classifications. These different classifications are termed the domestic rate, the intermediate rate, and the manufacturing rate.

For bills rendered quarterly and the quantity of water used expressed in cubic feet, the domestic rate applies to all water up to and including 10,000 cu. ft. per quarter. The intermediate rate to all water used from 10,000 to 100,000 cu. ft. per quarter, and the manufacturing rate to all water from 100,000 cu. ft. to 1,000,000 cu. ft. per quarter. Those consumers using over 1,000,000 cu. ft. per quarter are usually granted a straight rate for all water used, the price for this rate being often fixed at the manufacturing rate. After the rates are computed, an estimate of the annual revenue may readily be calculated, and, if no errors have been made the estimated revenue will approximate very closely the actual requirements.

Safeguarding Water Department Accounts.—One problem which usually comes up at the time a new water rate ordinance is adopted is the question of free water and special rates. In order to protect the water department it is advisable to put a provision in the ordinance whereby the governing body may grant special rates by resolution, but in all cases where special rates are granted the difference between the special rate and the regular rate shall be paid to the water department from the general funds of the city. This provision in the ordinance gives ample protection to the water department and makes it impossible to misappropriate any money which rightfully belongs to the department. In this connection all water used by the city for any purpose whatever should be paid for just the same as if the water works were privately owned. If all of these precautions are taken and the rates made sufficient to take care of operation, maintenance, depreciation, and interest and principal of bonds, the water works will have no trouble in becoming self supporting and will be an asset to any city instead of a liability. To this end, however, the water works department must be well managed and only experienced and efficient men employed.

In adopting a schedule of rates as outlined in this paper, there will at first be considerable criticism from the public, as the change is quite radical and entirely different from the old method. In my opinion, the people as a whole are fair, and if care is taken to give the schedule proper publicity, no serious opposition will develop.

Removing Submarine Rock With Jack Hammers

Plant Used in East River, New York, Described in The Military Engineer

By W. L. KUEHNLE,
Assistant Engineer, First New York District

On the examination of the bottom of the East River, New York, numbers of large boulders and small areas of ledge rock were found rising above the projected depth for heights of from ½ ft. to 10 ft. and containing from a ½ to 100 cu. yd. each.

It is considered economically impracticable to pick up scattered boulders with a dredge, especially if they are lying on bare ledge or other hard material. Past practice, when a small number of these boulders were to be removed, was to hire a derrick barge with a diver to sling them out, the maximum size handled being limited to the capacity of the derrick, usually 20 tons, or 10 cu. yd. Ledge rock areas were either reduced by surface blasting or by the employment of a drill boat for breaking the rock and a dredge to remove it. This practice was costly work for small quantities. It is a well known fact that one of the most costly items of subaqueous ledge removal, especially in waters where comparatively rapid currents exist, is the removal of the small projecting points of ledge left above grade, due to poor breaking up of the rock resulting from insufficient powder charges, inaccurate spacing of holes or insufficient depth of holes.

Use of Air Operated Jack Hammer Suggested.—The examination in 1921 of an area in the East River, dredged by one of the largest dipper dredges on the Atlantic coast, having disclosed a number of boulders and some small areas of ledge that the dredge was incapable of removing, it was decided to try out and develop the jack hammer operated by a diver. It was suggested that these jack hammers operated by divers, to drill the holes required for blasting, might reduce the cost of removing the larger boulders and smaller areas of ledge by breaking them into pieces readily handled by the divers, and pushed into deeper water or removed.

An experimental plant was then built for the use of the hammer and it was early seen that the method was practicable and that it was only a question of perfecting the details of operation to make it satisfactory and economical. After seven months of trial and development of the experimental plant, it was redesigned and reconstructed to increase mechanical efficiency and to reduce the operating crew to a minimum.

The Plant.—The plant, as now designed, consists of a barge 110 ft. long and 32 ft. wide with 10-ft. sides, on which is installed a 20-ton stiff leg derrick with 13 in. by 15 in. by 55 ft. trussed boom and 15 in. by 15 in. by 42 ft mast, the hoisting engine being a double 9x10 in., 3-drum, Mead-Morrison. Four anchors are handled on 2 double-drum Lidgerwood engines, the anchors being about 1,600-lb. and the line ¾-in. wire rope. The throttle, clutch and brake levers of the hoist and anchor engines are carried to an operating stand on the upper deck for one-man control of hoisting and maneuvering operations.

An 8x8x8 in. Gardner horizontal single-stage compressor and an 8½ in. Westinghouse cross-compound compressor furnish the air for the jack hammers, at 100 lb. pressure at the throttle and through a reducing valve and tank to the divers. Electric power for light, blasting and the divers' lamps is furnished by a 10 kw. Troy-General Electric generator, at 115 volts, 80 amperes. This generator is also used to charge 8-volt, 60-ampere storage batteries used for night and riding lights, thus obviating the maintenance of steam at night.

The bar for sweeping is suspended by two ¼ in. wire rope cables from one side of the barge. It consists of a 30 ft. length of 10 in. 30-lb. I-beam with two 8 in. 13.7-lb. channel extensions giving a total clear length of 50 ft. It is handled by a double 4x8 in. single-drum, throttle-reverse engine, and is so sensitive that an adjustment of 0.05 ft. in depth of the bar can be made.

Steam is furnished by two Coatsville upright boilers, each having 547 sq. ft. heating surface, 9 sq. ft. grate area, and 125-lb. pressure.

The divers' helmets are equipped with telephones so that constant com-

munication is had to deck, and delays in reporting underwater conditions are eliminated, and requests for tools complied with.

To handle small shoals of material other than rock, 1½ cu. yd. Blaw-Knox single-line clam shell bucket is provided and a 7½x5x6 in. duplex Worthington pump to serve the water jet used by the divers.

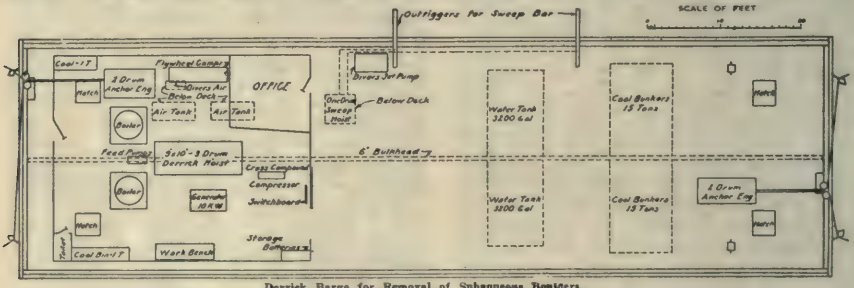
The drill steels are ⅞ in. hexagonal with ⅛ in. hole through the center, sharpened with bits from 1¼ to 1⅞ in. by eights, and are in lengths from 2 to 5 ft. From 6 to 12 in. of effective drilling can be obtained with each hit before resharpening, depending upon hardness of the rock.

The crew consists of a superintendent, a surveyman to locate and map the work done, an engineman, a fireman, a cranesman, a rigger, who also acts as powder man, four deckhands, two of whom act as divers' tenders, and two divers. On the 16-hour night watch a fireman and a deckhand were employed.

How the Plant Is Operated.—The operating procedure is to anchor the barge near the location of the shoal to be removed, with a spread of anchors to give the maximum movement of the barge. The sweep bar is lowered to the project depth and two divers go down. The barge is then pulled over area with a diver following at each end of the bar until it strikes the obstruction. A thorough examination is made by both divers and their recommendation is sent over the phone to the superintendent in charge. If the obstruction proves to be a boulder that can be removed as a whole, it is at once slung in wire rope or chain slings; if not, one or two jack hammers are sent down on the derrick falls and holes are drilled into the top, the depth and number depending on the height above grade, size of boulder, etc. If the total number of holes to be drilled exceeds what can be done during one slack water the holes are plugged until all are completed, when they are loaded and fired. The explosive used is usually Dupont 60 per cent gelatine, 1¼x8 in. size, with one or more sticks to a hole. When a crevice is found, 5 lb. of explosive is usually placed in it at the same time to aid in the shattering of the rock into small pieces.

After the charge is fired the divers make an examination of the results. Larger pieces are slung and smaller ones are either pushed into deeper water or placed in a basket constructed of band iron for removal, the amount removed being only that needed to make grade as shown by the sweep bar.

If the shoal proves to be of any material than ledge or boulders, various methods are used to reduce it, depending on the size, character of material, and depth of water above the shoal. When there is water two or more feet below grade, about a shoal of gravel or stiff mud which is not over 10 ft. in its smallest dimension, the shoal may be pulled down with an I-beam drag or it may be washed down by a water jet in the hands of the diver. If the area is large it is removed by the clam shell bucket.



Derrick Barge for Removal of Subaqueous Boulders

Fig. 1—Derrick Barge for Removal of Subaqueous Boulders

Work of Plant on Ledge in East River, New York.—The operation of the plant for removal of ledge is illustrated by the removal off the foot of East 23rd St., East River, of an area of ledge about 70 ft. long and 30 ft. wide above project grade of 25 ft., with a minimum depth of 21.0 ft. over it. The material was hard Fordham gneiss, having a specific gravity of 2.33. The depth of water surrounding it for 30 or 40 ft. was between 25.5 and 27.5 ft. so that practically

all of the broken rock had to be picked up. Work was commenced July 19, 1922, and completed Sept. 7, 1922, a total of 43 working days. See part of work chart (Fig. 2).

In the East River, due to tidal currents, only the period near slack water can be worked by divers and experience has shown that 11 slack water periods a week is good work. On this basis there were 79 slack water working periods in the time consumed on the job, of which 77 were worked; two slack waters were lost, due to collision. During two of the slack water periods but one diver was working.

A. M. Divers drill 6 holes, also drill 1 ft. farther into 1 ft. hole started last night. Plugged holes.

P. M. Divers load holes with 14 lb. dynamite and blasted.

Slung one piece blasted rock and filled 2 baskets with small pieces. (Note: Basket holds about 1 cu. yd., loose measure.)

This job was near the limit of the economical capacity of the plant designed for removal of boulders and points or pinnacles of ledge. While unit costs figured out to be relatively high, the total cost was less than was practicable through the use of a standard ledge removal plant including drill-coat, dredge, scow, tug, etc., either by contract or by lease of plant, by reason of large overhead or general expense, and the small quantity (90 yd.) and thin cut (less than 2 ft. average), together with the time consumed in attempting to "clean up" such an area with a dredge.

With sufficient scattered work to keep this plant employed, it has proved more economical than other methods and has attracted the favorable attention of contractors. In waters where current conditions permitting continuous diving operations, its economic efficiency would undoubtedly be materially bettered.

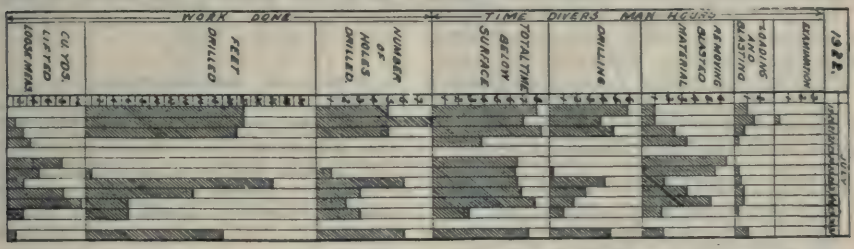


Fig. 2—Work Chart for Ledge Rock Removal Shell Reef, East River, New York.

Summary of Work Done

Man hours, divers down	268
Man hours, divers drilling	114
Man hours, loading and blasting	26
Man hours, slinging	120
Man hours, examination, etc.	7
Total penetration	528 ft.
Average drilling rate per hour	4.62 ft.
Total number of holes drilled	161
Dynamite used in holes	280 lb.
Number of surface blasts	8
Dynamite used in surface blasts	13 lb.
Cu. yd., place meas. rock removed	90.4*
Cu. yd., loose meas. on deck, estimated by foreman, day to day	160.6
Unloading	3 days

*This figure was computed from soundings taken before and after removal and was checked by measuring the displacement of the load on the deck of the scow and dividing by the weight of a cubic yard as determined by the specific gravity of a 1,000-lb. sample; 83 cu. yd. being the figure so obtained, the difference probably represents the amount blasted and pushed by the divers into deeper water surrounding the ledge.

Field Costs

Labor	$3,707.97	
Supplies (dynamite, exploders, oil, wire rope, etc.	709.55	
Fuel (bituminous coal)	352.79	
Renewals	90.00	$4,860.31
Rental of plant		
Derrick barge, E. R. No. 101	457.39	
Tending tug, "East River" @ $60 per day	2,880.00	
Launch service	30.99	3,368.38
Supervision	81.05	81.05
Total cost		$8,309.74

The foreman's report of the maximum day's drilling, which is somewhat typical, is as follows:

Cast Iron Pipe Production in September

The U. S. Department of Commerce announces the following statistics on the production, orders, sales, and shipments of cast-iron pipe for the month of September, 1923. The report includes returns from 12 establishments and is confined to bell and spigot pressure pipe exclusively.

Cast-iron pipe produced during the month (tons)	77,186
Cast-iron pipe shipped during the month (tons)	78,101
Orders for cast-iron pipe specified to be shipped from stock (tons)	14,215
Orders for cast-iron pipe specified to be made (tons)	156,585
Orders for cast-iron pipe not specified as to sizes (tons)	1,802

Problems of the Private Water Company

Abstract of an Address Presented Before Pittsburgh Chapter National Association of Cost Accountants

By W. W. COLLEDGE

The Public Service Company Law was passed by the legislature of the Commonwealth of Pennsylvania in 1913. Together with its supplements and amendments, it gives the public service commission, a body of seven members, the power to regulate rates and generally to supervise the activities of all public service companies including water companies. The administration of this law gives rise to the problems to be discussed here.

What are the interesting problems that confront a water utility company? Certainly selling water looks like easy money. Were any of you to enter the business of furnishing water to the public, you would discover obstacles of which you never dreamed. You, of course, picture a water company as dealing in a product of nature, with scarcely any production costs, selling an article of universal demand without style changes and upon which the seasons have but a moderate effect. Add to these advantages a franchise that protects you against competition and then say, "What more in the way of safety and profit can anyone expect?"

Comparison of Selling Water and Selling Shoes.—Perhaps you would compare selling water with, say, manufacturing shoes, where leather and supplies are bought a year in advance in the quantities past experience indicates will be necessary, and at market prices that are average a year before the order is placed on the books. Machinery is rented for which a royalty must be paid for each operation performed on a pair of shoes. Skilled workmen must be employed, subject to union rules, without knowing what their output month by month will be. Traveling salesmen must be financed at present day costly hotel and railroad rates, and it must be determined now whether it is safe to make an order for a customer whose credit may be doubtful months later, when the goods are ready for shipment. Goods must be boxed. Advertising is necessary. Cancellations may be received. Freight, express and mail rates must be known. The changes in fashion must be studied in order to decide when it is advantageous to change styles with all the attendants expense for new lasts. Salesmen's samples must be disposed of at the end of the season at a loss. Solesmen must be watched to see that they sell not just shoes, but certain proportions of fine shoes along with cheap shoes, so that all of the grades of leather will be used up at the end of the season. Many other contrasts could probably be drawn, whether you compare with the shoe business or your own.

Now take the other side: In the business of manufacturing and selling shoes, or in most any other business, the profits are not limited; therefore the selling price can be made whatever the purchaser will pay, and profits thereby increased. If you would take the time to study what we might say is the cost of supplying this very necessary article of common use, water, you would find something like this:

Revenue Distribution of Water Company.—The public service commission would allow you to receive a gross revenue of say $100,000; 32 per cent, or $32,000 of this would go toward cost of pumping (such as labor, supplies, maintenance and fuel, if a steam plant, or electric power, if an electric plant); 7 per cent, or $7,000 would go for labor, supplies and maintenance in connection with purification of the water; 7½ per cent, or $7,500, would go toward paying the cost of distribution and maintenance of distribution system; 22 per cent, or $22,000, would go for general and administrative expense (such as salaries, office expense and supplies, etc.); 9 per cent, or $9,000, would be the allowance for depreciation; the balance, or 22½ per cent, or $22,500, would be the amount available for the payment of interest on bonds, if any outstanding, and dividends on capital stock.

So that, in the case of a water utility company, in order that it may pay a fair return on investment, it is not the amount of money it can charge for its product, because that is already fixed, but the amount of money it can save in operating expenses that is to be considered.

Eventually there comes a time when the gross revenue allowed is not sufficient to pay the operating expenses and allow a fair return, which in the case of water utilities of the Commonwealth of Pennsylvania is 7 per cent. It then becomes necessary to file a new schedule of rates. Engineers and accountants must be employed to ascertain the fair value of the plant and the average operating costs for perhaps a period of years.

This information must all be gone over carefully before the schedule of rates is filed with the public service commission. Then immediately, when the schedule of rates is filed, the first thing that users of water think of is the filing of complaints, alleging that the rates are unreasonable and excessive. After this will ensue a long siege of conferences of engineers and accountants and hearings before the public service commission, which are costly; then the long delay in the handing down of a decision by the commission.

If either side is dissatisfied with the decision, there is the long period of waiting, in order that appeals and counter appeals may be filed and heard, before the matter is finally settled.

What the Charge for Water Covers.—In the manufacturing or trading business prices can be immediately changed to meet changed conditions. A good illustration of the average consumer's attitude was brought to my attention by a client, and is this: A customer complained of the amount of his bill, stating that he could not see why the water company was allowed to charge so much for something that they receive from God. He was told that the company had a reservoir full of pure water in the hills and that they would permit him to have all he wanted, free of charge, but he must furnish the team and wagon, the tank to hold the water, and a man to drive the team. The customer immediately said, "Well, look at the expense I will be put to to furnish the means of transporting the water from the reservoir to my home" and my client said, "Yes, that is just what we are charging you. We are not charging you for the water, but we are charging you for your proportion of the cost of transporting that water to your home and making it available for your use, as soon as you turn the faucet."

Numerous other incidents of like nature might be cited, to show the trend of the public mind in regard to the charge for this very necessary article. Consider, for instance, a customer who phones that his meter is running wild, or that he is going to move, and would like to have the meter read, or some other service. He expects that the water company will have a man on the premises immediately to take care of his wants, and that man must be a man of ordinary intelligence and acquainted with the various troubles that come up in connection with meters, leaks in house service lines, etc., in order that he may be able to handle the particular case in hand. The consumer cannot understand why such high rates of wages must be paid and so many men must be carried, who probably, a good part of the time, are doing nothing.

Another matter of interest is that a water utility, in making any but current improvements and extensions to its plant, cannot, under existing conditions, pay for same out of its net earnings, but must secure additional capital, either by the issue of additional capital stock or by the issue of bonds. This is not due to any specific regulation of the public service commission, but is a condition that comes about through the limited fair return that a water utility company may earn after paying cost of operating. It is very essential that the company be able to show that the proceeds of certain issues of stock or bonds were used in particular extensions or improvements.

The System of Accounting in Pennsylvania.—In the matter of accounting, which is regulated by the public service commission, the bureau of accounts and statistics of the commission on January 1, 1918, prescribed a uniform classification of accounts for water companies which requires all companies to keep their books by the double entry method, and prescribed the number and titles of accounts which they are permitted to use. These accounts are grouped under the following headings:

(1) Balance Sheet Accounts; (2) Fixed Capital Accounts; (3) Income Accounts; (4) Surplus Accounts.

Water utility companies are divided

into four classes, according to gross revenue, and a separate schedule of income and surplus accounts is prescribed for each class, the balance sheet and fixed capital accounts being the same for all classes. Companies having a gross revenue of more than $250,000 are known as class "A" companies. Companies having a gross revenue of $50,000 to $250,000 are known as class "B" companies. Those having a gross revenue of $5,000 to $50,000 are known as class "C" companies, and those having a gross revenue of $5,000 or less are known as class "D" companies. This system of accounting also requires that the companies must keep their books and records in the State of Pennsylvania, and that no records may be destroyed without the consent of the public service commission. No new accounts may be opened by the utility company without first obtaining the permission of the commission.

You can now see that running and financing a water company is no child's play; that, although one gets away from various problems encountered in a manufacturing business, he is so hampered in the price he can charge for his product, that a water company business resolves itself into a business of saving. Unless careful accounting is used and correct-management applied, the water company game will prove a game of charity so far as stockholders are concerned.

Conveyor and Bin Method of Handling Aggregate

A labor saving arrangement for supplying the sand and stone to the mixer for underground concreting on the Metropolitan Sewerage projects at Milwaukee, Wis., is used by Wenzel & Hennoch, Contractors. The set up is shown in the illustration. The aggregate is brought to the job in motor trucks, and is dumped into the hopper of the Barber-Greene conveyor, which carries it to the bin. The regular hopper of the conveyor has been built up on each side to the width of the trucks. A wooden ramp enables the trucks to get to the proper height above the hopper. One compartment of the bin holds 30 cu. yd. of stone and the other compartment holds 15 cu. yd. of sand. From the bin the material is proportioned to the mixer below. The conveyor loads the bins in the morning, being shifted so as to discharge into either the sand or stone compartment. It is stated to have unloaded 10 4 yd. trucks in 50 minutes. The conveyor is tended by one man. However less than half his working time is required there and he thus is free part of the time to help out at some other place in the mixing plant.

Set Up for Handling Aggregate for Underground Concreting at Milwaukee.

Supervision of Water Treatment Plants in Michigan

Supervisory Control of State Board of Health Described in Paper Presented Oct. 24, at 9th Annual Meeting of Iowa Section of American Water Works Association

By EDWARD D. RICH,
Director, Bureau of Engineering, Michigan Department of Health

Almost the entire state of Michigan is covered with a deep glacial drift largely deposited as terminal morains. These formations as well as some of the underlying rocks yield abundant supplies of water usually of a potable character though often so hard as to render their use disagreeable and expensive. Lakes are numerous through the state, many of which are used as the source of water supplies. The four great lakes which border the state are extensively used for the same purpose.

The Water Supply Situation in Michigan.—Although the state is not densely populated, few, if any of our surface water sources can be considered safe at all times for domestic use without some kind of treatment.

The water supply situation in Michigan is summarized as follows:

Total Number of Public Water Supplies....305

Ownership

Municipal	270 or	88.5%
Private	30 or	9.8%
Combined	3 or	1.0%
State	1	
Federal	1	

Source

Ground water, 201 or 65.9 per cent, serving pop. of 645,280.

Surface water, 104 or 34.1 per cent, serving pop. of 1,881,620.

Treatment

Filtration with chlorination, 13, serving pop. of 354,200.

Filtration with chlorination to be installed within 1 year, 4, to serve 1,220,800.

Chlorination only, 50, serving pop. of 1,663,700.

The population of Michigan in 1920 was 3,668,400, 61.1 per cent of which is urban and 38.9 per cent rural. The population served by public water supplies was 2,526,900 or 69 per cent. The population served by treated water supplies was 2,017,900 or 55 per cent. Fourteen ground water supplies are treated with chlorine either occasionally or continuously. Five of these are from deep wells which show some signs of contamination part or all of the time, probably from defective casings or abandoned wells. One is from rather shallow wells near many dangerous sources of contamination such as sewers, privies and cesspools. In two cases such conditions formerly existed, but deeper wells have been put down and the supply improved. Five supplies are from rather shallow wells near sources of contamination not positively dangerous, such as polluted streams. One has a long suction main passing through polluted water and liable to inward leakage.

Filter Plants Have Own Laboratories.—All filter plants in the state maintain their own laboratories. Of the 50 chlorination plants, 41 have analyses made regularly, 33 in laboratories maintained by the municipality and 8 in other laboratories of recognized standing, none of these being of the commercial type. In four instances the chlorine dosing apparatus is kept for emergency use and regular analyses are not required. In two places chlorination has been installed recently and laboratory service has not yet been established. In only three cases are cities delinquent in conforming to state requirements in respect to laboratories.

When attempting to supervise water works systems for the purpose of controlling the sanitary quality of the water delivered the sanitary quality of the water delivered it is decidedly important that the supervising body know the exact quality at all times and that some one directly connected with the water system be made responsible for maintaining the required quality. To accomplish this the State Board of Health adopted a resolution which requires that after January 1, 1916, whenever a water supply is subjected to treatment of any kind to improve its sanitary quality, the management must provide facilities for making laboratory examinations as frequently as deemed necessary by the State Board of Health and that the results of these examinations must be forwarded to the Board each month on blanks furnished by the state.

Of course, some difficulties were encountered in attempting to establish laboratories at each treatment plant and it was often difficult to find the proper person to place in charge of them. At the present time there are 50 laboratories in the state making water examinations regularly for 54

water systems and the results of these tests are reported each month to the Michigan Department of Health. The examinations are made as nearly as possible in accordance with methods adopted by the U. S. Public Health Service for determining the sanitary quality of water used for drinking purposes on interstate carriers and the standards recommended by the U. S. Public Health Service are used as standards for the water supplies of the state.

Work of the Laboratories.—One could hardly expect each laboratory to do scientific work of the highest order, but it is significant that, so far as can be learned, even in the laboratories at the smaller plants the results continuously correspond very closely to those obtained from samples occasionally collected and examined in the Laboratory of the State Department of Health at Lansing. By using prepared dehydrated media the bacteriological plantings are made comparatively simple and it has been found that by having some one from the State Department of Health spend about two days with some intelligent local person, sufficient instructions can be given to enable him to carry out routine plantings and properly fill out the report blanks. Whenever reports show that the analyst is in need of further instructions or, upon request, other visits are made and assistance freely given.

It has been found important in giving the first instructions to closely follow routine procedure only. The analyst is not asked to interpret results, but is simply required to record his findings on the report blanks. After he has had time to become acquainted with routine procedure we make all reasonable efforts possible to give instructions in interpretation of results and in the cause and effect of water supply contamination.

Some of our laboratories are located in high school buildings where one of the teachers performs the analyses and usually this has proved satisfactory where part time services must be accepted. This arrangement has decided educational advantages well worth considering. During the vacation season some teacher remaining in the city or a high school student is placed in charge of the work.

The rapid decrease in typhoid fever in the state during the past ten years and especially in the cities which in former years had very unsatisfactory water supplies has apparently shown good results from our efforts. In 1913 the death rate for this disease was 3.6 times the rate for 1922 in the state as a whole and 4.8 times the rate in the cities which now treat their water supplies.

Roof Truss Derrick Erects Standpipe

In the construction of two standpipes for the city of Dallas, Tex., an interesting erection method was used by the Chicago Bridge & Iron Works. The Method is described in The Water Tower, from which the matter following is taken.

The standpipes are 60 ft. in diameter and 100 ft. high. The design is very heavy, the plates in the lower course being $1\frac{7}{16}$ in. thick, approximately 7 ft. wide, 24 ft. long, and weighing more than 10,000 lb. each. The plates in the successive courses higher are the same size, gradually decreasing in thickness and, consequently, in weight; those in the top ring weighing something over one ton each. A large portion of the plates in these standpipes were so heavy that they could not be hoisted into plate buggies and moved in the customary manner. Conditions seemed to demand some form of derrick capable of easily hoisting and handling these heavy plates, the most desirable type being one that could raise all the plates and handle all the material at one setting. The problem, therefore, was to provide, at a comparatively small expense, a 35-ft. boom derrick capable of raising material 100 ft. in the air, and able to turn a complete circle.

The cost of a specially built derrick of the proper dimensions, to be shipped to the work and then taken away, was prohibitive. A wooden staging could be built to support a small derrick, which, however, could not be easily rigged to swing a complete circle without moving either guys or stiff legs, and which we knew would be clumsy and cumbersome in operation as well as difficult and expensive to install.

These standpipes are covered with conical steel roofs which are supported by a series of 24 radial trusses. The happy thought suggested itself that the trusses themselves could

be so detailed that they might be used to form the derrick desired.

Sixteen of the trusses were used in assembling the mast, which was approximately 130 ft. high and 8 ft. square. The boom, 35 ft. long, is made of two trusses. There being 24 trusses to each standpipe, the derrick was located out of center so that the six remaining trusses could be raised and placed in final position before dismantling the derrick.

The derrick was operated in the usual manner with double-drum engine and swinging gear. The hoisting cables lead to the bottom of the derrick and out to the engine through small holes drilled in the bottom ring. The engine was operated by compressed air, which had to be provided on the work to operate riveting hammers.

Adolph Eastman was superintendent in charge of the work.

Bids to Be Taken in December on $4,000,000 Pueblo, Colo., Flood Protection Project

Progress of the Pueblo Conservancy District, providing flood protection for Pueblo, Colo., has reached a stage indicating that bids for the work can be received sometime during December. The work will be formally advertised in November or December. It involves the construction of a new river channel to carry 125,000 cfs of water, 34 miles of railroad tracks, and a barrier dam 35 ft. high and 3060 ft. long. The Plan has been officially approved and benefits appraised, upon which the assessments will be levied. The total estimated cost of the project, including land and administration, is $4,000,000.

The work has been divided into 48 contract units. A contractor may bid on any single unit or any combination of units. He may thus confine his interest to such work as is best suited to his equipment and organization.

The work includes 1,000,000 cu. yd. excavation and grading as a single contract. The material will be excavated from dry cut to form new channel. The work is suitable for one plant consisting of trains and steam shovels or draglines, divided as follows: 160,000 cu. yds. shale from side hill, placed in railroad fill before September, 1925, and 50,000 cu. yds. from bottom, placed between September, 1925, and May, 1926; 180,000 cu. yds. earth placed in railroad fill before September, 1925, and 130,000 cu. yds. between September, 1925, and March, 1926; and 261,000 cu. yds. earth placed in levees before September, 1925, and 220,000 cu. yds. between September, 1925, and May, 1926. The above excavation will be dry except for possibly a small amount of seepage water, which may be drained by gravity, and the average train haul will be about 0.7 mile. In addition there will be 364,000 cu. yd. of other excavation and 281,000 cu. yd. rolled fill embankment in dam. The concrete will include the following:

Levee and channel slope paving, 10 in. thick, 96,000 sq. yd. extending 13,600 ft. in length, half placed before September, 1925, and half between September, 1925, and May, 1926. 20 per cent is below ground water line, but can be drained by gravity. Headgate structure, 660 cu. yd. reinforced concrete including 870 ft. of 48 in. concrete pipe, built during September and October, 1925. Retaining Wall 1,400 cu. yd. concrete, built before September, 1925. Culverts as follows: 2—8x10x130 ft., built before July 1925, and 3—12x10x100 ft., built early in 1926, each culvert being a contract unit. Concrete Through Girder Bridge, 3-track, 200 ft. long, 4,200 cu. yd. reinforced concrete, complete by July, 1925. Bridge Substructures, (a) for a 400 ft. double track 4-span through railroad bridge, 2,000 cu. yd. before March, 1926; (b) for a highway bridge and viaduct, 1,300 cu. yd. before March, 1926; (c) for a street bridge, 1,600 cu. yd. before March 1926; (d) for a street bridge, 2000 cu. yd. before March, 1926; (e) for a 400 ft. double track 2-span railroad bridge, 3000 cu. yd. before September 1925; (f) for a highway bridge, one 280 ft. span, 660 cu. yd. before September, 1925, each lettered item being a contract unit. Dam, 6 miles west of Pueblo, including spillway of plain concrete 4,900 cu. yd. wing walls of plain concrete 600 cu. yd. railroad conduit of reinforced concrete 1,600 cu. yd. ditch culvert of reinforced concrete 100 cu. yd., before September, 1925.

Additional information may be obtained by communicating with the Pueblo Conservancy District, Pueblo Colorado, or the Dayton Morgan Engineering Company, Chief Engineer Pueblo, Colo., or Dayton, O.

Ohio Conference on Water Purification

The third annual Ohio Conference on water purification with the State Department of Public Health will be held at Columbus, O., Nov. 21-24. The meetings will be held in the Southern Hotel. The first day of the conference will be devoted to the presentation of original papers and their discussion, including the following:

Water Purification at Toledo, 1916 to 1923. By R. W. Furman, Supt., Filtration, Toledo.

Effect of variation in character of filter sand upon:

Performance of the Filtration Process.

Effect of double Chlorination of Filtered Water.

Explanation of Reactions Taking Place During Carbonation of Lime-Soda Softened Water and Which Improve the Character of Influent Water for Filtration. By H. T. Campion, Supt. of Water Works, Defiance.

Further Studies on Comparison of Dougle Coagulation and Single Coagulation of Ohio River Water. By F. E. Sheehan, Supt. Filtration, Portsmouth.

The Water Works Accounting System Developed at Napoleon, By H. V. Holzer, Supt. Water Works, Napoleon.

Method of Carbonation Recommended for Columbus. By C. P. Hoover, Supt. of Filtration, Columbus.

What Constitutes Good Laboratory Technique in Bacteriological Examination of Water? Demonstration and discussion by C. T. Butterfield, Assistant Bacteriologist, U. S. P. H. S.

Progress in Studies on Limitations of Water Purification Processes. By H. W. Streeter, Sanitary Engineer, U. S. P. H. S.

Some Impressions of Filtration Plant Operation in the South. By A. E. Kimberly, Welch Chemical Co., Columbus.

The second day will be devoted to inspection. Trips will be made to the new water purification and softening plant nearing completion at Newark, O., and to the new water purification and softening plant at Delaware, O.

On the third day there will be discussions of the water purification problems assigned for research during 1923. Several filtration superintendents also will describe interesting and in some cases entirely original features of plant operation in use by them. The "question box" for new problems in water purification also is a feature of the morning session. The afternoon meeting will be a joint session of water filtration superintendents with the city and county district health commissioners of Ohio. The principal subject to be considered will be: Treatment of public water supplies with iodine as a goiter preventive measure, and the "Seal of Safety" for drinking water supplies.

The last session will include comments on operation of the water purification plants in the state and an inspection of experimental carbonation at the Columbus plant.

Gas From Sludge

In a paper presented at the 1923 Congress of the Royal Sanitary Institute of Great Britain, A. J. Martin gave an interesting discussion of the possibilities of obtaining gas from sludge by spontaneous combustion. He stated that it was not necessary to generate the gas in the septic tank itself. The retention in such a tank of large quantities of sludge periodically thrown up into the sewage by the evolution of gas was not conducive to the clearness of the effluent. A better plan was to remove the sludge from the tank at short intervals and to digest it in a separate chamber. The digestion of sludge in an independent tank had been carried on in many places for some years, not with a view to the production of gas, but for the purpose of reducing the volume of the sludge and rendering it inoffensive and non-putrescent. This was done on a large scale at Birmingham; and in this case the question of gas production had not been lost sight of. The money value of such gas was very considerable. That gas could be produced from any ordinary sludge seems to be beyond doubt. In the case of Imhoff tanks, it was often given off so copiously as to cause considerable embarrassment from "foaming" in the vent shafts. The gas could either be used to generate power or as a source of light and heat.

Financing Water Main Extensions by City Owned Plants

Method of Securing Necessary Money Described in Paper Presented at Last Annual Meeting of Iowa Section of American Water Works Association

By H. F. BLOMQUIST
Superintendent of Water Works, Cedar Rapids, Ia.

The pipe system may be classified into two main classes. The distributors and the feeder mains. The distributors are the grid iron arrangement of small mains, usually 6 or 8 inch pipes serving the individual fire hydrants and blocks of consumers located along its various lines. The feeder mains are the large pipe lines which conducts water from its source to the various sections of the city to supply the distributors.

The distributors are of value only to the abutting property owners whom they serve with water, and to whom they furnish fire protection. In general, an extension of distributors do not add to the usefulness of the water system except as a means of serving the particular owners who may make connections with them. In other words, they are set apart for the use of a certain group of individuals, and can not be used by any other group. In this respect, they are different from all other parts of a water system. The source of supply, pumping machinery, purification plant, etc., serve all consumers in common as the needs may be, and improvements or additions to them are equally valuable to all people served by the water system, but this is not so with improvements or additions to the distributors.

Financing Distribution System Major Problem.—The pipe system of a water works represents from one-half to three-fourths of the total investment in the plant, and the small pipes, or distributors, represent the greater portion of the ordinary pipe system. An increase of 100 per cent in the cost of water main construction in a short time, together with an increasing demand for water main extensions in rapidly growing cities have made the financing of them a major problem, especially in Iowa where there is as yet no authority for financing them by frontage tax, or a special local assessment against the benefited property.

Because of the large investment necessary in distributors, and recognizing the fact that they serve only a certain group of individuals, most of the states have passed statutes which are upheld by the courts, that permit municipally owned water works to charge all or a portion of the cost of such extensions to that group. A common practice in those states is to make extensions upon petition of the owners of a majority of the abutting property, and make an annual assessment of usually from 5 ct. to 10 ct. per front foot of abutting property for a period of 10 years. Another method used is to make direct special assessment of from two-thirds to the total cost of the extension and certify for collection in yearly installments according to the governing laws. The details of the plans are left for each municipality to work out.

Advantages of Special Assessment Plan.—There are several advantages of the special assessment, or frontage tax system for financing main extensions, among which are the following: Extensions can be made into new and sparsely settled territory without loss to the water department, and people who would otherwise not be able to get the benefit of public water service may have it at a nominal expense usually much less than any other water supply would cost them. Parties interested in opening new additions can have extensions made without being obliged to guarantee incomes, or pay interest on the investment in a direct way, or to put in water mains at their own cost.

Where special assessments, or frontage tax is not permitted, water departments have resorted to various other methods of dealing with main extensions. Some cities make extensions under contracts with owners of property, by which the owners guarantee an annual income of a certain percentage of the cost of construction. Others require the land owners to make the extension at their own cost,

and when sufficient number of connections have been made, that the revenue equals a certain percentage of the cost, the water departments will take the extension over at construction cost, or valuations to be made according to contract stipulations. These systems have worked fairly well where ownership of property is vested in one or two parties, but where lots have been sold to individuals, this arrangement becomes difficult and cumbersome and can rarely be used.

Consumer Eventually Pays All Costs.—Whether a system of assessment of costs in main extensions is followed by which a portion of the income for water service is derived, or whether some other method is used, the fundamental principle remains that the consumer must eventually pay all costs of the service. There are, however, some decided advantages in one system over another due to differences in business procedures necessary to provide the required funds. Where no form of assessment or tax for mains are used, all the costs of extensions must come in the form of water service charges, and since the outlay in mains is necessary long before income from them is available, the department must resort to the issuing of bonds or other form of indebtedness for carrying the investment until returns from the same will be sufficient to liquidate them. Frequent issues of bonds are undesirable, and often hard to bring about where popular vote is required, and is more costly than the more direct way of partially paying as you go. On the other hand when charges are made in one form or another as soon as mains are laid, and services available, the financing of extensions becomes greatly simplified.

It must be considered, however, that if a part of the income is derived from assessment or taxes, the rate for water sold should be correspondingly lower. One is simply a method of dividing the cost of service into two parts, one of which is payable as soon as water service is available, and may be considered as a ready to serve charge; and the other part when water is actually used. Courts have sustained ready to serve charges in public utilities other than water service, but the principle involved is the same whether it is water, gas or electricity. From the view point of moral justification for such division of charges it may be stated that the actual difference in sale value of property before and after water is available is generally much more than the amount of assessments, or other form of ready to serve charges.

Some just objections to making a change from a non-assessment system to the other might be raised on the grounds that owners of property along which future mains are to be laid will be required to pay more for water service in the form of assessments or frontage taxes, than owners where mains were laid before who got them without any extra expense. These differences would not be great, however, and are offset to some extent by the older consumers having paid a greater portion, in some instances at least, toward the purchase or building up of the water plant.

Proposed Iowa Law.—In order to simplify the financing of water extensions, and yet overcome objections to an abrupt change from a method of no assessment or charges, to one which involves special assessments or taxes, a proposed law was introduced in the Iowa legislature at the last session, but failed to pass, which provided for assessments against the benefited property in an amount equivalent to the cost of a 6 in. main, but with this difference from the ordinary methods: that after a property owner had made connection to the mains, and became a regular consumer, the amount of assessment paid would be refunded to him. This method would simply throw the burden of carrying the investment of water mains in unproductive territory upon the property owner until he would require water service. This principle can be defended on the grounds that the property would be increased in value after water is available to fully offset the expense of carrying the investment. In reality, it would be only a ready to serve charge for the assurance of being able to have water service, which would be of actual value to the property owner.

Based upon experiences with the problem of financing extensions under both methods, it is the writer's opinion that the ready to serve charge, or assessment plan for municipal water works meets the requirements much better because it distributes the cost of service more equitably and makes it possible to meet the needs of water service extensions much more readily.

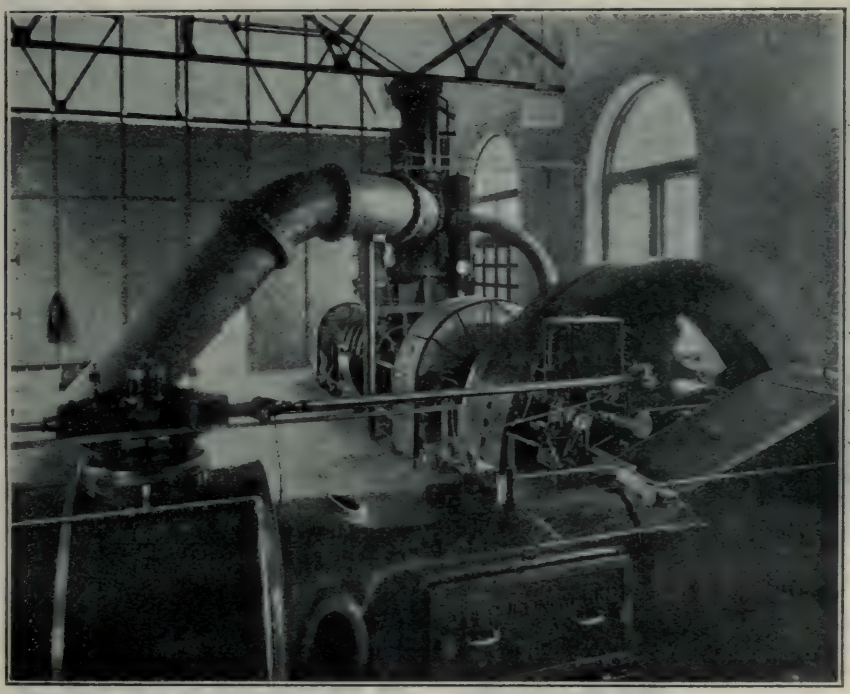
The New Pumping Unit of Trenton, N. J., Water Works

The rapid growth of the city of Trenton recently made it necessary to increase the capacity of its pumping station. The water is taken from the Delaware River and pumped by two 20 M. G. D. motor driven centrifugal pumps to a filter plant. These pumps operate against a 26 ft. head. For pumping from the filter plant to the reservoir against a 150 ft. head, there are two triple expansion direct acting plunger pumps of 15 M. G. D. and 20 M. G. D. capacity.

In Trenton there are numerous canals from which water is drawn by manufacturing plants. In winter the freezing of these canals throws an unusually heavy load onto the city water system; hence the demand is often almost double the normal requirement. These conditions sometimes last for a month at a time, during which the pumps must deliver about 30 M. G. D. By running both triple expansion pumps it was possible to get more than this capacity, but a breakdown of either unit would have been a serious matter. It was therefore decided to install a new unit and employ one of the old ones as a spare, and the other as a reserve for peak loads.

After a careful investigation involving visits to other plants and an exhaustive study by consulting engineers and the former commissioner, J. Ridgeway Fell, a Roots pump, made by the P. H. & F. Roots Co., Chicago, was selected for this important work. The pump is driven by an 850 H. P. Ames Uniflow engine, and on the same shaft there is a 300 K. W. Allis Chalmers D. C. generator for supplying power to the low-lift centrifugal pumps. Two steam turbo-generators formerly used for this work are now kept as spare units.

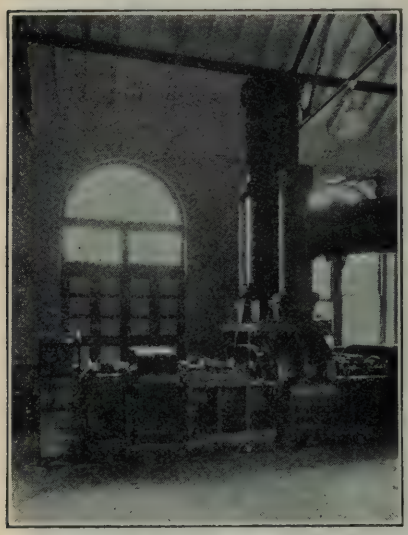
At the far end of the Roots pump the shaft is fitted with a coupling for an hydraulic turbine which it is contemplated installing upon acquisition of Sanhicon Creek, a water power canal. This will enable the city to use water power during 9 months



Roots Pump Installation at Water Works Plant of Trenton, N. J.

each year, with a consequent saving in coal.

The Roots pump is operated 24 hours per day. The pump is rated at 20 M. G. D. under a 155 ft. head at 140 R. P. M., but owing to its generous design it delivered its rated output at only 122 R. P. M., which gives it a capacity of about 23 M. G. D. at 140 R. P. M. The acceptance test, conducted by George A.



Another View of the Pump.

Johnson Co., Consulting Engineers, New York, showed the following results:

Rate M. G. D.	R. P. M.	Mech. Eff. Per Test Per Cent	Mech. Eff. Guaranteed Per Cent
20	121	83.1	81.0
15	98	82.1	81.0
10	70	82.3	81.0

It is stated that it is quite likely that these efficiencies, though already well above guarantee, will improve as minor adjustments are made and the pump tuned up to its working conditions.

Because of the impracticability of tests for volumetric efficiency, this was checked by computation, using known design factors and actual related data taken during the test. The results were as follows:

Rate M. G. D.	Volumetric Efficiency (By Computation) Per Cent	Volumetric Efficiency Guaranteed Per Cent
20	93.0 plus	93.0
15	91.5 plus	91.5
10	88.0 plus	88.0

Method and Cost of Constructing Malone Diversion Dam

Government forces have recently completed the construction of the Malone diversion dam in the Klamath Project of the U. S. Bureau of Reclamation. The dam is located on Lost River, about 10 miles below Clear Lake Reservoir and about 45 miles southeasterly from the city of Klamath Falls, Ore. The construction of the dam is part of the plan for the irrigation of about 5,800 acres on the west side of Langell Valley and about 4,300 acres in the vicinity of Bonanza, Ore. Stored water will be released into Lost River from Clear Lake Reservoir and diverted into the west canal at Malone Dam. We are indebted to the September Reclamation Record for the following details regarding this work.

The dam consists of an earth embankment with a spillway and canal head-gate structure of reinforced concrete. The spillway and the head-gate structure for the west canal are located on the west side of the river; there is also a small head-gate on the east side. The earth embankment is 400 ft. long. Its maximum height is 32 ft., the upstream slope is 3 to 1, and the downstream slope 2 to 1. The spillway structure is equipped with two radial gates 10 ft. high and 16 ft. long. The capacity of the spillway is 4,000 cu. ft. per second. The dam will raise the water surface about 18 ft. above normal.

On the west side of the river the foundation consists of lava bedrock; near the center of the channel the bedrock dips downward. The eastern half of the river channel was underlain with lava bowlders and gravel mixed with clay, ash, and cinders. East of the river bed the above materials were covered to a depth of 6 ft. with a black mucky material, which was composed largely of vegetable matter; this was removed before placing the material for the embankment. The principal quantities are: Embankment, 18,500 cu. yd.; reinforced concrete, 452 cu. yd.; and riprap, 1,732 cu. yd. The work was begun in July, 1922, and completed in May, 1923.

The water at the site was about 8 ft. deep. Cofferdams consisting of juniper trees and earth were constructed above and below the dam site.

The river water was by-passed through a small timber flume; the flow amounted to only a few cubic feet per second. Little difficulty was experienced in removing the water between the cofferdams. The excavation of the mucky material in the river bed was done with a stiff-leg derrick operating a clamshell bucket. The excavation for the spillway and the head-gate structures was done principally by teams and slip scrapers.

Construction of Embankment.—In building the embankment about 3,500 cu. yd. were placed with fresno scrapers and 15,000 cu. yd. with dump wagons. The average length of haul for the fresnoes was about 300 ft. and for the dump wagons about 1,000 ft. The dump wagons were loaded by fresno scrapers through an overhead trap. The dump wagons had a capacity of 2 cu. yd., about 40 trips were made per day. The earth was spread in 6-in. layers and was well sprinkled and rolled with a heavy corrugated roller. The embankment was completed on Oct. 31, 1922.

Concreting Operations.—Concreting was begun in October, 1922, and completed in May, 1923. The concrete materials were placed on the hillside about 20 ft. above the crest of the dam. The mixer was placed about midway between the concrete materials and the spillway structure. A trestle was built from the mixer to the forms; the concrete was partly wheeled and partly chuted into place. About one-half of the total yardage was placed during freezing weather. During cold weather the mixing water was heated and after pouring the concrete was protected by firing.

The channel leading to the spillway structure was paved with a grouted paving. The upstream face of the dam is protected with riprap 18 in. in thickness. The downstream side is protected with riprap about halfway up; the upper half of the downstream face is protected with large sized crushed rock.

Rock for concrete was crushed on the job. Rock for the crusher and for riprap and paving was obtained from two quarries, one about 200 ft. and one about 2,000 ft. from the dam. Sand was shipped in from Marysville, Calif. The sand, cement, reinforcing steel, metal work, timber, all equipment and supplies were hauled in by motor truck from Dairy, Ore., a distance of about 27 miles. Contract hauling was at the rate of 23 to 30 ct. per ton-mile.

Equipment and Wages.—The principal equipment used on the job was as follows: 1 stiff-leg derrick, 72-ft. boom; 1 concrete mixer, 10 cu. ft.; 1 hoist, reversible, 6-hp., gasoline; 1 jaw crusher, 10x22in.; 1 air compressor, 9x8 in.; 2 Fordson tractors; 2 air drills; 2 centrifugal pumps, 4 and 8 in.; 1 clamshell bucket (rented); 5 dump wagons (rented).

Common labor was paid $3.60 to $4.50 per day; more-skilled labor, $4.50 to $5; carpenters, $7. Horses were rented at $20 each per month, the United States furnishing subsistence.

The job was always short of men and the turnover was high. Under more favorable labor conditions the cost could have been reduced below that shown in Table I.

Table I—Cost of Malone Diversion Dam

Item	Unit	Quantity	Cost Unit	Cost Total
Surveys and testing	.....	.....	.....	$ 1,794.26
Right of way	.....	.....	.....	31.25
Clearing	.....	.....	.....	63.40
Cofferdams	.....	.....	.....	1,896.68
Excavation:				
Class 1, dry	Cu. yd.	740	$1.77	1,314.15
Class 1, wet	Cu. yd.	2,440	1.51	3,681.97
Class 3, wet	Cu. yd.	810	2.11	1,713.77
Class 3, dry	Cu. yd.	880	1.81	1,683.90
Embankment	Cu. yd.	18,500	.72	13,476.25
Puddled back fill	Cu. yd.	3,400	1.56	5,309.36
Reinforced concrete	Cu. yd.	452.5	44.01	19,874.96
Structural steel	Lb.	.....	.....	114.83
Grouted pacing	Sq. yd.	145	7.09	1,029.41
Riprap	Cu. yd.	2,246	5.67	12,738.74
Gates, etc.	Lb.	17,000	.163	2,771.22
Camp maintenance	.....	.....	.....	6,108.19
Engineering and inspection	.....	.....	.....	2,058.06
Superintendence and accounts	.....	.....	.....	5,669.11
General expense	.....	.....	.....	5,662.65
Total	.....	.....	.....	$86,992.16

Water Works Accounting System of Charleston, S. C.

Extract From Paper Presented April 19 at Annual Convention of Tri-State Water and Light Association

By E. EARL EVANS
Treasurer and Assistant Secretary, Water Department of Charleston, S. C.

The city is divided into 10 major districts. Each district is divided into routes of approximately 150 meters each, which is considered a day's work for a meter reader. Each meter is numbered as to district, route and reading number. These figures appear on every record pertaining to that meter.

A meter reading card, sixe 4x6 in., is made out for each meter. These are filed according to district, route and reading numbers. The ledger cards, size 5x8 in., are filed in the same order in a cabinet. This cabinet is on rollers so as to permit of being rolled into a fireproof vault at night.

Meters Read Quarterly.—Meters are read quarterly, with the exception of industrial meters, which are read monthly. The bills are made out from the meter reading cards, the day after the meters are read, on a mechanical billing machine. The ledger cards are posted from the bills. The total amount billed each day is summarized both as to consumption in cubic feet and amount in money. These figures are posted on control cards in the ledger cabinet.

At the end of each month these control cards are summarized and the totals posted to the general ledger. The cash receipts for each day are posted on the control cards as well as on the individual customers' cards, and the outstanding balances carried forward. This system enables the officers to ascertain the net amount outstanding in each section of the city at the close of each day's business.

At the expiration of 10 days after rendition of bill, should the bill remain unpaid, a delinquent notice is made out in triplicate. The original is mailed to the customer, the duplicate serves as an order on the street department to discontinue service if the bill is not paid within five days and the triplicate remains in the office as a record.

Meter Installation Orders.—Orders for installing new meters, services, hydrants, valves, or for repairing old ones are made on 3x5 in. cards and a varied color scheme is used to indicate meters, services, etc. These cards are all returned to the accounting department after the work is completed, with the cost of the work indicated thereon in itemized form. This information is compiled and posted to the general ledger monthly, the individual cards being filed in order of street and number for future reference.

All purchases are made on requisition to the manager, who issues order in triplicate. The original goes to the source of supply, the duplicate to the party issuing the requisition and the triplicate is retained in the files. When the invoice for goods is received it is filed with the triplicate of the order. Upon receipt of the goods the party for whose use they were purchased receipts the duplicate order and returns it to the office for attachment to the triplicate and invoice. The invoice is then approved for payment and vouchered.

The General Books.—The general books consist of three: cash book, voucher record and general ledger. Besides these various subsidiary ledgers are carried, all of which are card ledgers.

The cash book is ruled in columns for the various classes of receipts and disbursements. Only the totals of columns are posted monthly to the general ledger.

The voucher record, a large loose leaf book, provides for a detailed classification and distribution of expenses both for operation and improvements. In this book is recorded all information from the vouchers, which in turn are based on reports from the pumping station, data compiled from the working cards previously referred to, the customers' records and approved invoices. Like the cash book only the totals of columns are posted to the general ledger.

From the general ledger is compiled monthly a statement of earnings and expenses and an asset and liabilities statement. The earnings and expense statement shows all earnings and expenses for the past month, the same month of the preceding year, the present year to date and the corresponding period of the preceding year. These two statements, together with reports indicating the pumpage of water from the plant, amount of

water consumed through customers' meters, number of new taps, number of new meters and a few other similar items, are furnished the management for his information and the preparation of his monthly reports, and serve as a guide in the directing and controlling of future operation.

Sinking Fund and Depreciation Charges.—As soon as bonds are issued preparations should be made for their redemption, even though their date of maturity is in the distant future. We feel that bonds should not be issued for a greater period than the life of the improvements for which the proceeds from the bonds are to pay. The amount necessary to be set aside monthly, or annually, which at compound interest will retire the issue should be ascertained. This sum should be set aside and charged to "Operation." This will insure that the obligation will be met at maturity without embarrassment.

One thing that we must recognize is that with the passing of each birthday we are one year older and one year nearer the end of our existence on thi earth. We cannot fool ourselves in this respect by saying that we feel like 21. Just so with a water or light plant. No matter in how good a condition it may appear to be at the end of the year, it is one year nearer the end of its usefulness and its value on the books should be depreciated.

The company is not only legally entitled but morally bound to set aside a sufficient sum annually to make good depreciation and to replace the various parts of the plant as they wear out or become obsolete. This should be done before the net earnings are arrived at, and should be done before even if the net earnings appear in red figures or on the "loss" side of the profit and loss sheet. It is better to take a small loss in a lean year than to show a profit at the expense of the depreciation reserve account, for this loss will inevitably have to be borne at some future date.

It is a fault of many companies who do not set aside a fixed amount annually for depreciation, especially those not affected by income taxes, to cut depreciation charges to the minimum in order to show larger profits. It is better by far to over-estimate depreciation than to under-estimate, as it often occurs that a portion of the plant must be abandoned, even though still in good working order, because it has become inadequate to meet the demands of the business or because it is found to be more economical to install newer and more improved types.

Accounting for Extensions and Additions.—When you consider that at the beginning of the last century there were only 16 water works plants in the United States and at the close of the century the number had increased to approximately 3,500 plants, it will be seen that this business is in a state of rapid expansion. This being the case, it is necessary to be continually erecting or laying extensions, or making additions to buildings or machinery.

With extensions and improvements continually in the process of construction it is extremely important that exact cost be kept, in order that labor and material used in this work is not charged to operation, but to the plant account. The improper charging of labor and material is not the only thing to be guarded against. It is important to guard against the failure to charge material taken out of the storehouse.

Have you ever taken an inventory at the end of the year and found two 16-in. valves where there should have been three? You probably worried over it a while and then passed it up. The value of this valve appeared in your annual report as a loss on inventory. What percentage of your losses on inventory is buried in those extensions made during the early months of the year? Your loss on inventory cut down your earnings, while your plant shows on the books at a false value, below its actual cost. This is the fault of the construction foreman, whose duty it should be to keep an itemized account of all material used in the construction of extensions and report to the accounting department.

A properly designed accounting system will draw information from every department of the business and correlate this data in such a form as to furnish the executive with reports which will act as a chart by which he will be enabled to steer his business course. If improperly designed it will be merely a record of past events, depicting more or less accurately the financial status of the business as of a given date.

Industrial Notes

The Orton & Steinbrenner Co., 608 So. Dearborn St., Chicago, Ill., manufacturers of locomotive cranes, buckets and coal crushers, has just completed a large addition to its works at Huntington, Ind., which will approximately double the output of the company.

The National Steel Fabric Co. has appointed H. D. Beaton eastern manager with headquarters in the Harrison Bldg., Philadelphia, Pa.

The United States Cast Iron Pipe & Foundry Co. announce the appointment of Thomas P. Anthony as Chief Engineer of the company with offices at Burlington, N. J. P. T. Laws has been appointed Southern District Manager of the company, with offices at 1002 American Trust & Savings Bank Bldg., Birmingham, Ala.

H. B. Ackland has been appointed manager of the New York offices of C. H. Williams Co., manufacturers of clam shell buckets. Mr. Ackland was for many years connected with the Westinghouse, Church, Kerr & Co., as engineer in charge. The New York office is located at 30 Church St.

Everett H. Allison, formerly of the Allison Engineering Co., Consulting Engineers, has joined the staff of the Buhl Machine Co., in assisting their trade with the various engineering problems they may encounter. Mr. Allison was formerly connected in an Engineering capacity with The Aluminum Ore Co. of East St. Louis, Ill., and with Ingersoll-Rand Company of New York City.

The Nichols-Moore Co., Advertising, of Cleveland, O., announces a change in name to The Nichols-Evans Co. and an addition to its staff of Walker Evans, Jr., formerly with Blackman Company, of New York, and later with MacManus of Detroit. The officers of The Nichols-Evans Co. are Walker Evans, Jr., President; D. H. Nichols, Vice President and Treasurer; E. J. Witthoff, Secretary. There are no changes in the company personnel, or in accounts served, other than above cited.

Obituaries

Charles T. Harding, Jr., superintendent of the water works and light plant at Virginia, Minn., was drowned at Pelican Lake, Minn., on Nov. 1.

Edward E. Sands, consulting engineer, died Oct. 22 at the home of his father at Milwaukee, Wis. Mr. Sands was born in Columbus, O., Jan. 5, 1877. He was instructor in Civil Engineering, University Wisconsin, 1900-1902; city engineer, Sparta, Wis., 1901-1902; project engineer, U. S. Reclamation Service 1902-1909; manager, Upper Columbia Co., 1910; U. S. Reclamation Service, 1911; supervising engineer, Canadian Pacific Ry., 1912-1913; city engineer, Houston, Texas, 1913-1918. Consulting Engineer since 1918. Designed and built activated sludge plants of Houston; designed most of terminal facilities of Houston Ship Channel; twenty million dollars worth of irrigation works; Supervising Engineer of Camp Logan and other camps. Since Oct. 1st, 1922, member of the Engineering firm Hawley and Sands, designing and supervising water and sewerage plants at many Texas points, including $1,250,000.00 sewage disposal plant for Fort Worth.

Statement of the Ownership, Management, Circulation, Etc., Required by the Act of Congress of August 24, 1912,

of WATER WORKS Monthly issue of ENGINEERING AND CONTRACTING, published monthly at Chicago, Ill., for October, 1923.

State of Illinois, County of Cook, ss.

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared E. S. Gillette, who, having been duly sworn according to law deposes and says that he is the Circulation Manager of the publication Engineering and Contracting, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Engineering and Contracting, 221 East 20th Street, Chicago; editor, H. P. Gillette, 221 East 20th Street, Chicago managing editor, H. P. Gillette, 221 East 20th Street, Chicago; business manager, Lewis S. Louer, 221 East 20th Street, Chicago.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.) H. P. Gillette, 221 East 20th Street, Chicago; Lewis S. Louer, 221 East 20th Street, Chicago; R. E. Brown, 904 Longacre Bldg., 42nd St. and Broadway, New York.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

E. S. GILLETTE, Circulation Manager.

Sworn to and subscribed before me this 1st day of October, 1923.

(Seal) KITTIE C. WOULFE, Notary Public.
(My commission expires Feb. 9, 1926.)

Railways

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.
221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*
LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 904 Longacre Bldg., 42d St. and Broadway
RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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Vol. LX. CHICAGO, ILL., NOVEMBER 21, 1923 No. 5

The Greatest Defect in Our System of Rate Regulation

The greatest defect in our system of rate regulation is failure to protect public service commissioners from public vengeance when rates are raised. Demagogs and "yellow" newspapers seldom refrain from attempting to make a political issue of rate increases, and they are frequently successful in securing the retirement of commissioners who have raised rates. Even when they fail in their efforts thus to punish commissioners they make life miserable for them, and thus often bring about the ultimate resignation of honest, competent commissioners.

About 18 months ago two public service commissioners of the state of Oregon were "recalled" by a three to two vote of the citizens of Oregon, because they had raised telephone rates. We have watched the newspapers for editorial comments on this recall, yet, outside of Oregon, it has received scarcely any mention. We hardly know how to interpret such editorial indifference to a political act that was so oturageous as was the act of retiring these commissioners.

It was not charged that these commissioners were dishonest. Their sole offense consisted in making it slightly more expensive to use a telephone. Obviously the voters could know nothing of the evidence upon which these commissioners based their decision that telephone rates should be raised. But the Oregon law permits the voters to recall public servants whose acts fail to please the majority of the public. We shall not now discuss the iniquity of such a law when it applies to judges or to those occupying quasijudicial positions. Our present object is merely to point out the outstanding reason why public service regulation has been a failure in the majority of our states.

Judges should not be subject to recall by popular vote, for courts are not designed as instruments to express the will of majorities but to

secure justice and to protect the rights of all. Public service commissioners are judges, and as such should be protected, as far as practicable, not merely from recall but from the attacks of demagogs and other self seekers. So long as the American editors see nothing worthy of comment in such political acts as the recall of public service commissioners, the country is a long way from securing a satisfactory system of regulation of railway and public utility rates.

Municipal Ownership of Public Utilities

Editorial in The Chronicle

Addressing the American Electric Railway Association in session at Atlantic City, C. D. Emmons of Baltimore, its president, said, in explanation of the attitude of public utilities toward municipal ownership, or public ownership: "Our opposition is not because we fear the loss of our property—the laws of this country protect all enterprises from confiscation without payment of the full value of the property taken. Our opposition is not due to fear of loss of profits, for some of the largest railways in the country have made no profits for several years. Why, then, are we, and all other business oragnizations, opposed to public ownership? Because it is foreign to and in conflict with the fundamental principles of the American government; because it is socialistic; because it is, in nine instances out of ten, wasteful, saturated with politics and inefficiency, and because, once it is established as a principle, it means the end of the representative form of government and the beginning of socialistic government."

Mr. Emmons cites the case of the Detroit street railways, where great promises of saving were made that could not be kept, and offers a reason why these promises are unlikely to be kept in all similar cases: "Were it possible for a municipality to employ labor and buy materials at lower prices than privately owned companies must pay, demagogic promises might be kept." The sufficiency of this reason must be at once apparent to everyone. And there are several causes why such purchasing cannot be done. The main cause, however, is concealed in the lesser ones. And this is that despite all attempts to safeguard the expenditures under skilled supervision, the municipality does not await the best time to buy, does not have to require such basic prices as will insure a profit, and has for its chief interest in the outgo the immediate procurement of the utility trusting to the general promises made but disregarding the future course of management because no one's actual property is at stake in the enterprise.

Or so it seems. Yet just here is one of the fatal faults, for taxes to pay deficits are a contingency of all such undertakings. It may be unkind to say that many voters, though they know this, also know that such contingency taxes will not be paid by them, for they have no taxable property—but we do not doubt the truth of the statement, though we do not offer to estimate the degree. Mr. Emmons shows that Detroit was compellel to raise its 5 ct. fare. This is a contingency that the voter in many instances does not consider. Nor does he take into account the grip of union labor on the municipally owned enterprise, a grip that is even stronger than that exerted upon the privately owned, for politics makes men engaged in all city management afraid. The truth is that it has become entirely too easy to vote bonds for these municipally owned enterprises, such is the avidity of small communities, as well as large, for the possession of everything that will be "for the benefit of the city or town."

When private capital is invested it counts the cost. It selects a favorable time for the inauguration of the enterprise. Because it submits to supervision, it asks certain protection under a franchise. With all these precautions it faces the natural opposition of every new invention in the world of mechanics. But most of all it now faces, as the speaker indicates, the opposition which is concealed in all these vainglorious promises which have their roots in socialistic beliefs. Here is an urge which capital must contend with, for men are constantly pointing to savings that must come under public ownership. Inefficiency of those in charge is not mentioned, yet is almost universally true. The enterprise, founded upon the moneys that should go into retirements of bonded issues, runs along careless of

everything but the costs of operation. How many privately owned enterprises pay for themselves in a reasonable term of amortization? Here is one of the dangers not emphasized enough. "Let us have the utility—let us bond ourselves to get it"—and trust to good fortune to save us from disaster, is the prevailing spirit!

Successive steps take us from city to county, to state, to nation. Educated to believe in the right and power of government by a city to secure for the people all modern "improvements," the mind is led to accept paternalism by state and nation. Then when the private corporation operates a "utility," as it must, in the face of all exterior influences of capital and labor, new capital in new and untried ventures, old labor in new armor of insatiate demands, there arises the complaints of those disgruntled by these false socialistic teachings. How long, how very long, were the steam roads subjected to this suspicions and innuendo, rising in latter years to violent and thoughtless denunciation. Only within recent years and by the general education of temperate discussion have the steam railroads come into a fair heritage of good will. No private enterprise can succeed where the people are arrayed against it. None should succeed, or can, that does not serve. But in all our thought of these public utility corporations privately owned we should accord them their chance to win fair returns by fair methods.

We are aware that municipal ownership of public utilities is not socialism, that it is, in principle, only socialistic. The city is a form of corporation under the protection of the commonwealth. It has some advantages in ability to operate certain public utilities if kept free from politics. But such advantages as are derived from a limited, compact organization are sustained by the larger embracing political organism. Even admitting this, experimentation has not proceeded far enough to warrant wholesale adoption of this method. Time must elapse for the acquirement of utilities free from tax-bond mortgages. And the public utility, city-owned, must itself meet all competition of new methods and new instrumentalities before it can be said that municipalities are warranted in these hazardous undertakings.

Are Railway Engineers Dogmatic?

Editorial in The Railway Age

It is a common criticism of the medical profession that it is dogmatic, that it will brook no departure from the conventional in the practice of its members. Are we sure that the engineer, and particularly the railway engineer, is not sometimes to be included in the same category? One evidence of this is to be found in the reluctance with which the various railroads have taken up and adopted the standard practices approved by the American Railway Engineering Association. Another illustration is to be found in the experience of the supply manufacturer who seeks suggestions for improving the design of his equipment only to be confronted with opinions so diametrically opposed to each other and advanced with such positive assurance as to afford little opportunity for the introduction of modification which will serve to reconcile them. Railway maintenance and construction officers are busy men and by far the larger portion of their time is occupied with administrative rather than engineering problems. The pressure on them for results is so severe that they can hardly be blamed for accepting something as good practice which they know from experience will work, although careful analysis might show that some other method would give better and more economical results. Technical training is intended first of all to give the student the scientific point of view to the end that he will not be satisfied that he possesses the truth until he has considered all the facts which are concerned in any problem. But, in the rush of his daily work, the mature engineer is inclined to lose sight of this fundamental principle. The engineer owes it to himself, as well as those with whom he deals, to consider each task which comes before him with an open mind. It matters little whether the problem comes to him in the form of a report from an assistant or a call from a supply salesman or any other source of information. Before he condemns or endorses any proposition he should be sure that his decision is founded on a thorough knowledge of the facts.

Current Material Prices

Iron and Steel Prices

(From the Iron Age, Nov. 8, 1923)

Prices as of Nov. 6, f. o. b. Pittsburgh:

Open hearth rails, heavy, per gross, ton	$43.00
Light rails (25-45 lb. section), per 100 lb.	2.15
Track spikes, 9/16 in. and larger base, per 100 lb.	3.15
Track spikes, ½ in., 7/16 in. and ⅝ in., 100 lb.	$3.15 to 3.50
Track spikes, 5/16 in.	3.15 to 3.50
Spikes, boat and barge, base, per 100 lb.	3.50
Track bolts, ¾ in. and larger, base, per 100 lb.	$4.00 to 4.25
Track bolts, ½ in. and ⅝ in., base, per 100 lb.	$5.00 to 5.50
Tie plates, per 100 lb.	2.55 to 2.60
Angle bars, base, per lb.	2.75

Finished Iron and Steel

	Per lb. to large buyers. Cents
Iron bars, Philadelphia	2.67
Iron bars, Chicago	2.40
Steel bars, Pittsburgh	2.40
Steel bars, Chicago	2.50
Steel bars, New York	2.74
Tank plates, Pittsburgh	2.50
Tank plates, Chicago	2.60
Tank plates, New York	2.74
Beams, Pittsburgh	2.50
Beams, Chicago	2.60
Beams, New York	2.74
Steel hoops, Pittsburgh	3.15

Freight Rates

All rail freight rates from Pittsburgh on domestic shipments of finished iron and steel products, in carload lots, to points named, per 100 lb., are as follows:

Philadelphia	$0.32
Baltimore	0.31
New York	0.34
Boston	0.365
Buffalo	0.265
Cleveland	0.215
Cleveland, Youngstown, comb.	0.19
Detroit	0.29
Cincinnati	0.29
Indianapolis	0.31
Chicago	0.34
St. Louis	0.43
Kansas City	0.735
Kansas City (pipe)	0.705
St. Paul	0.60
Omaha	0.735
Omaha (pipe)	0.705
Denver	1.27
Denver (pipe)	1.215
Pacific Coast	1.34
Pacific Coast, ship plates	1.20
Birmingham	0.58
Memphis	0.56
Jacksonville, all rail	0.70
Jacksonville, rail and water	0.415
New Orleans	0.67

Rails and Track Supplies at Chicago

Standard Bessemer and open-hearth rails, $43; light rails, rolled steel, 2.25c, f. o. b. makers' mills.

Standard railroad spikes, 3.25c mill; track bolts with square nuts, 4.25c mill; iron tie plates, 2.75c mill; steel tie plates, 2.60c f. o. b. mill; angle bars, 2.75c, f. o. b. mill.

Jobbers quote standard spikes out of warehouse at 3.90c base and track bolts, 4.90c base.

Cement Prices

Quotations as of Oct. 30, per bbl., in carload lots, exclusive of package:

Pittsburgh	$2.24
Cincinnati	2.54
Detroit	2.48
Chicago	2.20
Milwaukee	2.37
Duluth	2.25
Minneapolis	2.50
Davenport, Ia.	2.43

Cross Tie and Lumber Prices

(From Lumber, Nov. 9, 1923)

White Oak Ties

F. o. b. cars, Chicago, Nov. 7)

No. 5—7x9x8	$1.80
No. 4—7x8x8	1.65
No. 3—6x8x8	1.50
No. 2—6x7x8	1.40
No. 1—6x8x8	1.30

Red oak ties, 10@15c less than white oak. Sap pine and sap cypress, 10c less than red oak.

White oak switch-ties, per M. ft.	$55 to $58
Red Oak switch-ties, per M. ft.	49 to 51

White Oak Ties

F. o. b. cars, St. Louis, Nov. 8

No. 5—7x9x8	$1.60
No. 4—7x8x8	1.47
No. 3—6x8x8	1.30
No. 2—6x7x8	1.20
No. 1—6x6x8	1.10

Red oak ties, 10c per tie less than white oak prices. Heart pine and heart cypress, same prices as red oak. Sap pine and sap cypress, 25c less than white oak.

White oak switch ties, per M ft.	$46.00
Red oak switch ties, per M ft.	42.00

Bridge and crossing plank, same prices as switch ties.

Market Prices of Lumber

	Flooring, 1x4, No. 1 Common	Flooring, 1x4, No. 2 Common	Timbers, 6x6	Timbers, 12x12
Boston—Yel. Pine	.....	.....	$53.00@57.00	$63.00@66.00
New York—Yel. Pine	$56.00	$40.00	50.00@52.00	57.50@63.00
Buffalo—Yel. Pine	51.00	31.50	.....	46.00@51.50
Chicago—Yel. Pine	46.00	30.00	.....	51.00
St. Louis—Yel. Pine	43.00	26.00	.....	41.50
Seattle, Wash.—D. Fir	56.00	52.00	26.00	.....

Southern Mill Prices

	Flooring, 1x4, No. 1 Flat	Flooring, 1x4, No. 2	Timbers, No. 1, 4x4 to 8x8	Timbers, No. 1, 3x12 to 12x12
Alexandria—So. Pine	$38.50	$26.25	.....	.....
Birmingham—So. Pine	41.15	19.17	.....	.....
Hattiesburg—So. Pine	38.61	19.30	$20.86	$24.97
Kansas City—So. Pine	.....	25.27	29.97	40.12

Frame and Pile Trestles in Electric Railway Practice

Extract From Report of Committee on Buildings and Structures Presented Oct. 9 at Annual Convention of American Electric Ry. Assn.

In the design of frame and pile trestles the particular loadings and local conditions obtaining on the property will determine the type of structure and dimensions of timbers. The committee, in making a study of this phase of the subject, has adopted two loading diagrams for live loads, namely, those shown in Figs. 1 and 2.

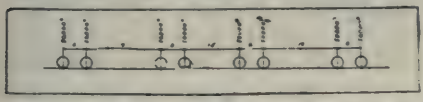


Fig. 1. Type A Loading Recommended for Roads Handling Freight Equipment.

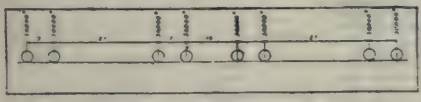


Fig. 2. Type B Loading Recommended for Roads Not Handling Freight Equipment.

Fig. 3 shows a typical frame trestle designed for type A loading and is adapted for railways handling steam road freight cars.

Fig. 4 shows a typical frame trestle designed for type B loading.

For structures other than a temporary nature, treated bridge timber should be used in trestle construction.

In computing the stresses from external forces in the various members of the structures, the assumed loadings, both live load and dead load, must be determined. The great majority of the small bridges, culverts and trestles of an electric railway are located on the interurban lines. The heaviest live load imposed on the bridge is therefore an interurban car, or cars fully loaded, an electric locomotive or steam railroad freight cars loaded with coal, gravel or other heavy freight.

Car Weights and Wheel Spacing.—In order to arrive at some conclusion the 1922 committee sent out a questionnaire on car weights and wheel spacing. The heaviest passenger car reported weighed 101,000 lb. The lightest weighed 29,700 lb. The heaviest steam road equipment handled was 140,000 lb. capacity gondolas weighing approximately 200,000 lb. fully loaded. The heaviest electric locomotive reported weighed 120,800 lb. The 1922 committee accordingly recommended two loadings depending on the service requirements. For roads handling freight equipment the loading recommended was as shown in Fig. 1.

For roads which do not handle freight equipment and which are not likely to do so in the future the 1922 committee recommended the loading shown in Fig. 2, which covers two 100,000 lb. passenger cars fully loaded with 125 passengers each and having

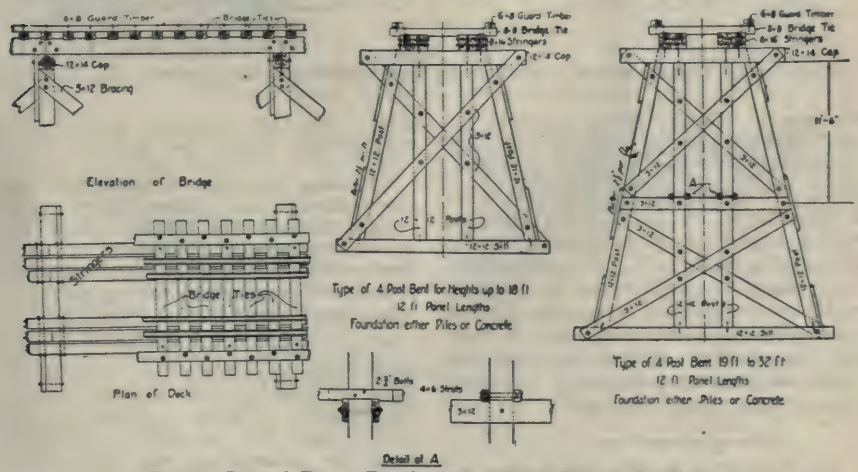


Fig. 3. Typical Frame Trestle Designed for Type A Loading.

an approximate total weight of 120,000 lb. per car.

There was considerable criticism of the loading recommended by the 1922 committee. The 1922 committee accordingly included the loading question in the questionnaire. Of the replies received ten members stated that the live loadings proposed were acceptable; two members thought they were too heavy and one member stated that the loading of Fig. 2 was too light. This member quoted the loading prescribed by Professor George F. Swain, chief engineer of the Massachusetts Public Service Commission. This loading is for a 40-ft. car weighing 50 tons and with a spacing of 5, 15, 5. No loading which might be recommended would be acceptable to all. The committee has tried to determine a loading which is sufficiently heavy for future developments and which also is fair and reasonable. It believes that the 1922 recommended loadings are consistent with good practice.

Bus Operation by Electric Railways.—Over 100 electric railways are now operating an auxiliary bus service. About 1,000 buses are used for this purpose, representing an investment of upwards of $6,000,000 for the buses alone.

Method of Releasing a Mired-Down Caterpillar Shovel

A simple and quick method of getting a 55-ton caterpillar-mounted revolving shovel out of a mud hole is described in a recent issue of The Excavating Engineer as follows:

Ordinarily a shovel has sufficient tractive power to pull itself out of ordinary sink holes with the help of planks, timber and brush, but occasionally the operator may, as this one did, find himself up to the top of his caterpillars in particularly tenacious mud. In this instance one of the caterpillars was all but buried.

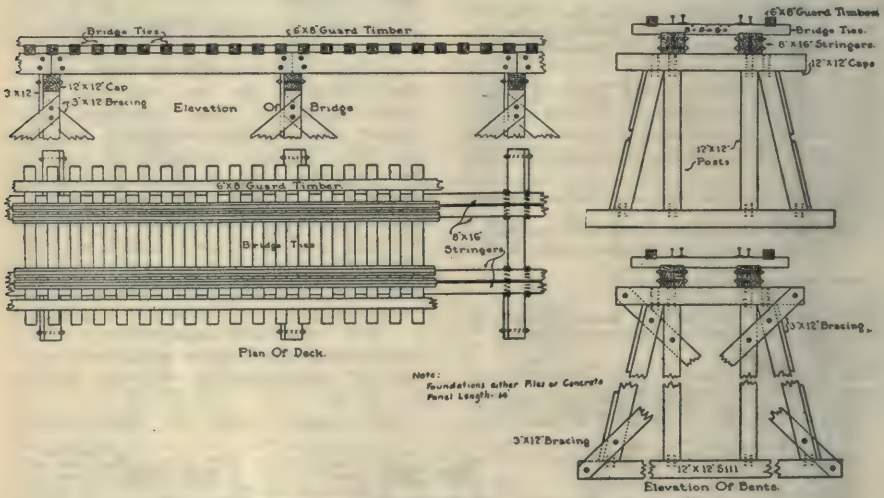


Fig. 4. Typical Frame Trestle Designed for Type B Loading.

Cribbing was placed alongside the low caterpillar. The shovel was swung around and by means of the power boom hoist, the boom was lowered on this cribbing, at the same time the dipper was thrust out as far as it would go.

This cribbing then acted as a fulcrum and the caterpillar was lifted up and planks and timber thrown underneath. More cribbing was added and the procedure repeated until the caterpillar was free. This fulcrum and lever arm action may be increased by loading the dipper.

20,000 Railway Water Tanks.—There are over 20,000 railway water tanks in use on the railroads of this country.

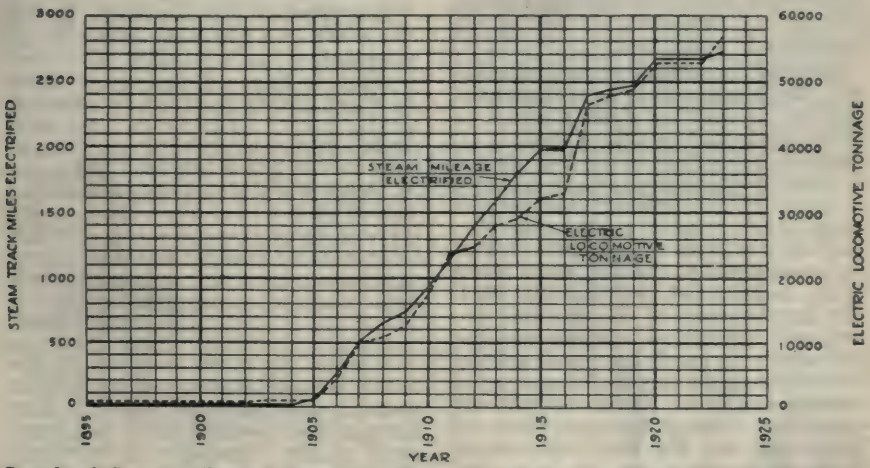
Development of Heavy Electric Traction

Extracts From Committee Report Presented Oct. 8 at Annual Convention of American Electric Railway Association

In some instances railroads having terminal electrification have extended such electrification over comparatively short branch lines in advance of extensive main line electrification, thus providing improved facilities for short haul suburban traffic. In other cases branch lines have been electrified by means of overhead trolley or third rail in advance of terminal or main line electrification. In a few instances this has been done even when such electrification was not immediately contemplated. There are also instances where railroads have granted trackage rights to interurban traction companies over branch lines, the traction company installing overhead trolley and operating an interurban passenger service and the steam railroad continuing to operate freight and through passenger service with steam locomotives.

With few exceptions branch line electrifications were made several years ago and there has been no material development during recent years. The recent tendency has been to substitute self-propelled cars for steam service on branch lines where through service is not essential and the maintenance of steam service is burdensome.

The Self-Propelled Car.—The self-propelled car (internal combustion engine, steam engine or storage battery) is undoubtedly of interest to those responsible for electric railroads as well as to the operators of steam road branch lines. The vehicle which can be operated on any track, whether it is electrified or not is a valuable transportation facility, and under many circumstances can compete favorably with the electrified system. The operating problems of the steam railroad branch line are often quite analogous to those of the interurban electric road, especially when the traffic demands are relatively light, and the most economical solution in either case may be electrification; or it may be gasoline, storage battery, or steam self-propelled cars. In at least one instance, electric operation of an interurban line has been abandoned in favor of gasoline rail equipment on account of a sudden falling off of business. Joint operation of various kinds of equipment is not uncommon and often provides a satisfactory solution for both local service and through traffic problems.



Growth of Steam Railroad Mileage Electrified and Electric Locomotive Tonnage in Heavy Traction Service in United States and Canada.

The Earlier Self-Propelled Cars.—The committee on equipment of the A. E. R. E. A. in 1912 compiled an extremely comprehensive report covering the development of self-propelled cars. The cars developed at that time were of various types, such

as gasoline, steam, compressed air, storage battery, etc. The most successful types, however, were gasoline cars with either mechanical drive, as in the McKeen car, or electric drive, as in the cars built by the General Electric Co.; and light storage battery cars. The then recent development of the Edison cell had provided a stimulus to the use of storage battery cars.

Subsequent to 1912 an interruption seems to have occurred in the development of self-propelled cars for branch line operation and the manufacture of the two leading gasoline driven types was discontinued. Storage battery cars have continued in operation, but extension of service has been slow in recent years.

Recently, on account of serious financial conditions which have prevailed and on account of traffic problems from public and private automobiles, renewed interest in the self-propelled car has been manifested. A number of roads in this country and abroad have adopted and are operating successfully, a type of gasoline driven car considerably smaller than those which were most common in 1912. The development of the gasoline engine and mechanical transmission for automobile trucks has undoubtedly been responsible for this recent rapid growth of light, self-propelled car operation. Many characteristics of these cars are identical with motor truck standards.

Types of Internal Combustion Cars.—Although in this country and Canada the railroads which have adopted internal combustion cars have conservatively adhered to light vehicles with four-cycle gasoline engines, the normal weight being 15 tons, nevertheless in Europe the Diesel engine with electric drive is being developed in capacities up to 250 hp. and weighs up to between 70 or 80 tons.

Storage battery locomotives have been developed for industrial yard switching to some extent, but their use is extremely limited. Those in service weigh from 20 to 40 tons and have tractive efforts up to 1,600 lb. on a one-hour basis. Lead cells are generally used for this class of equipment, usually at 200 volts and with capacities up to about 1,000 ampere hours.

Much remains to be done in connection with the collection of information on self-propelled cars, and your committee recommends that consideration be given to continued study of this interesting subject.

Recent Developments in Heavy Electric Traction.—During the past few years the development of heavy electric traction has been of necessity somewhat slow on account of lack of funds available for expansion. Many railroads, however, have actively considered the question of electrification as a solution for their individual problems, and several engineering investigations have been completed and plans made for electrification, some of which have been delayed pending more favorable conditions.

The Norfolk & Western R. R. has completed and placed in operation an extension of its electrified zone from Kimball to Farm, a distance of about 20 miles, involving about 50 miles of single track. That road has purchased four additional locomotives to take care of the extension. These are to weigh about 385 tons each. They are of split-phase type, as are the present locomotives, the principle difference being that the phase converter on the new locomotives is a synchronous machine which permits the attainment of virtually unity power factor at all times. The wheel arrangement is 2—8—2+2—8—2, the halves of each locomotive being symmetrical and interchangeable. Each half has two motors, with a gear ratio of 21 to 100. The drive is by means of side rods and jack shafts. The continuous tractive effort at 14 mph. is to be about 90,000 lb. with an hour rating of about 708,000. The four motors are rated at 1,000 hp. each.

The Pennsylvania R. R. is building three locomotives with identical series-wound, commutator motors. Two will operate on 600 volts, third-rail in terminal service in New York and the third, equipped for single phase operation, will be run between Philadelphia and Paoli.

The New York, New Haven & Hartford R. R. has purchased twelve new passenger locomotives of a type similar to those placed in operation in 1919. The wheel arrangement is 2—6—2+2—6—2, and the weight is to be approximately 180 tons. They are to have six pairs of twin motors with a gear ratio of 25 to 89. The continuous tractive effort at 40 mph. is 15,800 lb. The maximum tractive effort will be about 52,500 lb. The maximum safe speed will be 66 mph.

They are adapted to operation from the single phase trolley at 11,000 volts and from either an over-or-under-running third rail at 650 volts.

The Pennsylvania, the Long Island and the New York Central have each purchased considerable new multiple-unit equipment.

The Illinois Central, after an exceedingly thorough investigation, has completed general plans for the electrification of its tracks at its Chicago terminal. The electrification will involve the main line to Matteson, the South Chicago branch, and the Blue Island branch; about 37 route miles and 125 miles of track. The system will be 1,500 volts, direct current, carried in overhead trolley.

The Virginian Ry. has started the electrification of its line from Roanoke to Mullens, a distance of about 134 miles, involving 213 miles of single track. The traffic is nearly all coal and very heavy trains are hauled. It is planned to increase the tonnage of loaded coal trains to 9,000 tons. The system will be 11,000 volts, single phase, 25 cycle. The locomotives will be similar to those purchased by the Norfolk & Western Railroad.

The graphic chart of electrified mileage and tonnage of electric locomotives has been brought up to date to include the Norfolk & Western, Pennsylvania Railroad and New Haven locomotives, and the Norfolk & Western extension. It is of interest to note the continuing upward trend after an interruption in growth of electrification.

Exhibition of Power and Mechanical Engineering Equipment.—The second national exposition of power and mechanical engineering will be held Dec. 3 to Dec. 8, inclusive, at the Grand Central Palace, New York. The products to be shown include boilers, stokers, super-heaters, economizers, air preheaters, prime movers, pumps, condensers, valves, control apparatus, measuring instruments, handling equipment, transmission equipment, such as ball bearings, clutches, belting, etc., as well as machine tools. The exposition will be conducted by the International Exposition Co., managed by Charles F. Roth and Fred W. Payne, Grand Central Palace, New York City.

How to Temper ⅞-In. Hollow Steel Drill Heads

Method Described in Engineering and Mining Journal-Press

By S. L. BAKER

To temper ⅞-in. hollow steel drill heads, first punch a hole in the end large enough to protect the needle when the chuck gets worn a little. Then file perfectly level and do not trust any method except using the eye for leveling up the ends. I find this is a very important part. Then heat in a coke fire to a light red, almost to a scaling point, but not quite; heat clear down to the shank, then immerse ½ in. in water for about a half minute, or a little longer, if the temper comes down too quickly the first time; then take out of the water and rub the end on the anvil block or on something that will brighten; but always let the water dry off the end before rubbing to brighten.

Then let the temper draw down until the end is almost purple but not quite; then go back to the water with it the same as before. This time do not leave it in the water quite so long; then rub the end as before, but let the water dry first; then rub well this time and watch it closely. When the purple gets all over the end that has been brightened, go to the water as before, this being the last time; leave it in the water about two minutes, then take out and set away and let cool gradually. There will be no more trouble with the drill heads battering or breaking if the procedure as outlined here is followed.

Make a holder for the side of the water tub as large as the outside diameter of the drill steel. The shank part of the drill rests in this and keeps the drill only half an inch below the surface of the water when the water is kept in the tub at a definite level.

Hourly Wages in Industrial Plants. According to an investigation by the National Industrial Conference Board, New York City, the average hourly earnings of wage earners in August in industrial plants was 54.8 ct. This figure is based on reports from over 1,600 industrial plants in all parts of the United States.

Methods of Installing or Replacing Culverts and Pipe Lines Under Traffic

Extracts From Committee Report Presented Oct. 17 at 33rd Annual Convention of American Railway Bridge and Building Association

No work required of bridge and building forces calls for greater ingenuity and resourcefulness than the installation of replacement of culverts, sewers and pipe lines under traffic. Installations must be made with a minimum of interference with traffic and often without restricting high speed train movements.

Open Trench Methods. — When quicksand, soft muck or other unstable soil is encountered, and tunneling is impracticable, it is necessary to drive piling and construct a temporary opening the length of which is determined by the size of the pipe or culvert and its depth below grade. If the bents next to the pipe are driven far enough apart to allow for working room on each side, they support the side of the trench. If necessary, sheeting may be placed behind the bents. On account of the increased cost, especially if a work train is required to handle the driver, the driving of piles should be done only when absolutely necessary.

If the pipe is small and the open trench method is used it is advisable to transfer the track support some distance each side of the trench. One method is to place a section of second-hand bridge stringers about 6 ft. long flatwise under the track ties, under each rail. The trench should also be cross-braced with trench jacks.

The Pennsylvania R. R. accomplishes the same result by placing a track rail under the ends of the track ties, with the ball up, and immediately over it another rail on top of the ties, fastening the two rails with clamps made for the purpose.

The Illinois Central R. R. uses a rail hanger to support the traffic rail over trenches, carrying a rail on each side of the traffic rail with hangers that pass under the traffic rail and over the extra rails where the ties are not supported on account of the trench excavation.

If the pipe is large or if two or more pipes are placed side by side, one method generally approved is to dig a narrow trench under the track at each end of the section to be excavated, set up frame bents, and support the track on stringers placed under the track ties. This is a good method to use when it is necessary to remove broken pipe or old stone or timber culverts.

Methods of Replacing Old Box Culverts.—It is often necessary to replace an old stone box or timber culvert under an embankment that is so high that it is not practical to use the open trench method. If the inside dimension of a timber culvert is not more than 10 in. less than the outside dimension of the pipe, the bottom and sides can be adzed out to allow the pipe to be pulled into place by the use of a hand winch. A greased plank with a shovel blade under the end of the pipe will make the work easier. Some prefer two skids made of 2-in. by 4-in. timber placed 8 in. apart and spiked to the bottom timbers of the culvert. When it is necessary to remove the old culvert entirely, the open trench method can be used for the ends and the tunnel method for the portion under the tracks.

Tunnelling Methods.—One method of timbering a tunnel is to excavate carefully to the proper dimension and insert timber or plank sets as fast as the excavation proceeds, placing the mud sill and top first and, while holding the top in place with a jack, place the side pieces, after which a strip should be spiked to the top piece to keep the sides from crowding in. Another method is to excavate a tunnel 3 or 4 ft. wide, set up frame bents and drive lagging over the top of the bents, as the excavation is made, setting additional bents as the work proceeds. As only a small force can be employed in a tunnel it is advisable to work from both ends.

Tunnel work can be handled best during the winter season. Where new work is being put in (such as sewers and drainage district pipes) stakes should be set outside of the tunnel for line and grade. Where small pipe lines pass under several tracks, it is often advisable to sink shafts between the tracks and tunnel under the track between the shafts. If the ground is firm it is often possible to tunnel between shafts without using any supports if the pipe can be placed at once and the backfilling tamped into place around the pipe. A chain hoist is a valuable aid when lowering pipe down a shaft or into a trench.

Moving 7-Story Building for Railway Terminal Improvement

Methods of Moving Dowie Building, Chicago, for the Illinois Central R. R. Described in Paper Presented Nov. 5 Before the Western Society of Engineers

By HUGO FILIPPI
Engineer, Wm. H. Brown & Co., Chicago

Incident to the vast terminal improvement program of the Illinois Central R. R. and of special interest to engineers and to the public generally, the moving of the Dowie Building during the past summer has occupied a unique position in the public eye, owing to the location of the building, its size, weight and limited working space in which the work was done.

The Dowie Building, known also at various periods of its life as the Zion Building and as the Imperial Hotel, was erected about 30 years ago. The building reached its greater prominence as the home of the Zionist Cult under the leadership of John Alexander Dowie. It was purchased by the Illinois Central R. R. in 1907, remodeled and strengthened in 1914, and has since been used for office and record storage purposes.

The Building.—The building is seven stories in height, 81 ft. in width and 131 ft. in length. In construction, it may be classified as of the wall-bearing type, that is, wood joists supported by exterior brick walls and interior columns and girders of cast iron and steel. The north and west facades are faced with cut stone. The old foundation was of rubble supported on wide slabs of stone resting on blue sand, at about elevation minus one. No piling or wood grillage was used.

As a part of its terminal improvement program the railroad company was confronted with the problem of either demolishing the building or of moving it to permit the construction of the proposed Roosevelt Road viaduct, which will be undertaken at an early date and will extend eastwardly from Michigan Ave. across the old site of the building and the waylands of the railroad company to Grant Park.

Early this spring it became apparent that the question of either moving or demolishing the building should be decided without delay, and estimates covering the probable cost were prepared. The feasibility of moving such a large building were naturally very carefully considered, but as there appeared to be no physical or structural reasons precluding such a step it was decided that the building could be moved safely and without injury to the structure or to adjacent property.

The New Foundation.—The character of the soil on which the building would rest in its new location was next determined. Nine test holes were put down and a bed of very hard blue clay was found at elev. minus 1.5. An examination of these borings indicated that no piling would be necessary and the new foundations were accordingly designed with spread footings.

The unit soil pressure used in the design of the foundation was 3,000 lb. per square foot, as provided for in the city building code for the character of sub-soil encountered. The proposition of all footings was determined by considering the superimposed dead load combined with 50 per cent of the live load on all floors and the unit live load taken was 100 lb. per square foot for the first floor and 50 lb. per square foot for all other floors.

The new concrete foundation is essentially rectangular in plan. In addition to the footings supporting the enclosing walls of the building, one set of parallel walls was constructed for the east and west hallway and one set of parallel walls for the north and south hallway. In addition foundations were also built for the brick vault which extends to the third floor. Isolated footings for 14 interior columns were built ranging in size from 5 ft. 3 in. by 5 ft. 0 in. to 6 ft. 9 in. by 6 ft. 9 in. In general, all footings are 4½ ft. thick and are carried down to elevation minus 1.5, there being but few exceptions where the footings are carried lower. The top of the concrete floor was placed at elevation

plus 3.5, except in the boiler room, where it was carried down to elevation plus 1.0. All footings under exterior walls are 9 in. wide and the footings under interior walls are either 7 ft. or 7 ft. 6 in. wide. 1:2:4 concrete was used throughout. The foundation walls were finished off at elevation plus 3.82.

Notwithstanding the close proximity of the foundation walls to city datum, no waterproofing of any kind was used. The imperviousness of the walls and floors was proven in several instances during the heavy rains of the past summer, when the foundation was completely surrounded by water, and it is very gratifying to report that not a single leak of any character developed.

Constructing Concrete Foundations at New Site. Building to Be Moved Shown at Right.

All footings are reinforced transversely, and are sufficient depth to carry shear without stirrups, except in the case of three large beams which span wide openings. These beams are heavily reinforced with the full complement of longitudinal bars, bent bars and stirrups.

Foundation Construction Plant.—The concreting plant was simple in character and economical in operation. The governing idea in the design of this plant was the saving of labor. A planked roadway was constructed from Indiana Ave., which enabled all material trucks to conveniently reach the hopper, and the roadway was ramped up to the top of the hopper, the deck of which was built sufficiently heavy to carry the loaded trucks, thus permitting the trucks to stand directly on the hopper and to dump all sand and stone through open traps into the bins without the use of any manual labor.

Only two men were required to handle the mixer, one man handling cement and water and the other wheeling sand and stone. Through the use of the undercut gates it required about 2 seconds to fill a wheelbarrow, and as the wheel averaged only 5 ft., it was possible for these two men to keep the mixer going continuously. The 1-bag mixers were mounted on the side platforms of the hopper and the concrete was wheeled from the mixer to the forms in wheelbarrows and two-wheel dump buggies. The sand bin had a capacity of 20 cu. yd. and the stone bin 40 cu. yd. In addition, material was stocked on top of the bins to create an additional reserve. This plant was very economical in operation and assisted materially in the constant production of concrete of uniform quality.

View Showing Blocks and Cables Used in Moving, Also Manner in Which Track Was Laid.

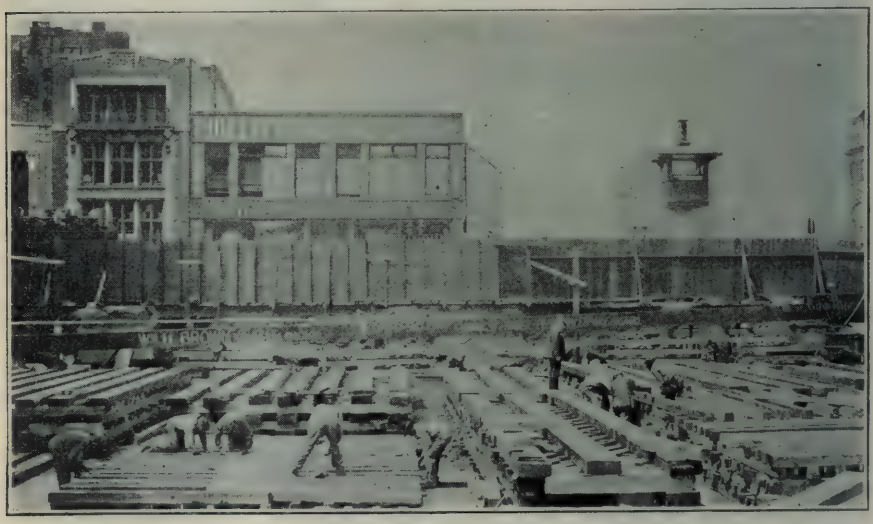
Underpinning.—Before any needle beams were placed, a diagram was prepared showing the probable spread of live and dead load through the walls. In making such a diagram, the location, spacing and sizes of windows and other openings is of paramount importance. It was found that a maximum total load of about 13 tons per linear foot of wall should be provided for and beams ranging from 15 in. to 24 in. in depth, placed in pairs, were used. In underpinning

any building the question of deflection rather than of moment is of prime importance and special care should be exercised to guard against excessive beam deflection, which might result in unsightly cracks in the building walls.

The first step in underpinning was the digging of open cribbing pits. These pits were carried down to the hard blue clay as a safeguard against settlement. Holes were then cut through the brick wall, one at a time, with a pneumatic drill and the needle beams were placed on the cribs and jacked up against the brickwork until the needles carried most of the load, the intervening brick piers carrying the balance. This general scheme was used for the south and east walls only, as will be explained later. The cribbing pits were placed sufficiently distant from the new concrete foundation to permit its construction. After the concrete walls had set up sufficiently, the load on the needle beams was transferred from the outside cribs to the top of the concrete wall and there carried until the general cribbing for the moving proper had been placed. This arrangement was necessary in order to provide a free working area within the foundation walls for pouring the floor and building the general cribbing.

Because of its proximity to lake level it was out of question to place any cribbing directly on the soil. To overcome this condition Mr. Brown decided at the outset to increase the thickness of the concrete floor to about 8 in., and to build all cribbing on this floor. This scheme proved practical and overcame the wretched muddy condition which would have resulted from the heavy rains of the past summer if the cribbing had been placed on the ground and the concrete floor constructed after the building had been moved, as is usually the case.

The north and west walls of the building below the second floor level are supported by cast iron columns. Here the problem was vastly different and it was decided to cut off these columns below the first floor level and to support each volumn on the two I-beams. The columns were cut off in two steps to a smooth, square bearing with an acetylene torch. The first step consisted of cutting out one-half of the column and inserting and jacking up an I-beam. After this had been done the remaining half of the column was cut away and the second I-beam was driven into place and jacked up to take its share of the load. In the case of the stone column, this procedure was not possible and the stone was cut away a little at a time and the load taken up by rails wedged tightly against the stone. The interior cast iron columns were handled in



Placing the Cribbing for Moving the Dowie Building.

the same general manner as the exterior columns previously described.

Longitudinal Timbering.—In general, longitudinal timbers were placed adjacent to all north and south walls. 20 in. by 20 in. by 90 ft. timbers were placed adjacent to the west and east walls. Incidentally, these timbers are said to be the largest ever hauled through the streets of Chicago. Other timbers for this purpose ranged in size from 12x12 to 18x18 in.

Arrangement of Tracks.—In all, 23 tracks were used for moving the building. These tracks consisted of four or more rails each, and extended completely under the building. Each track supported one line of needles or timbers.

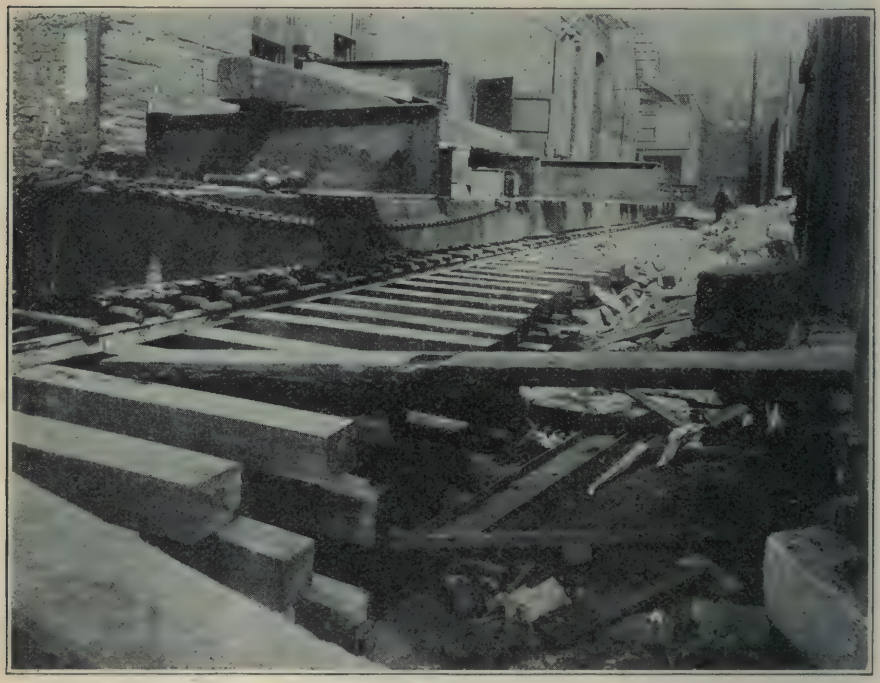
In loading a building ready for the rollers, it is first necessary to place jacks under each line of needle beams or timbers. The shoe timbers, roller plates and rails are then placed, after which rollers are set in position, the jacks removed and the load transferred from the jacks to the rollers. On this work the shoe timbers were 4x12 in., the roller plates 12x⅜ in., and the rollers $2\frac{7}{16}$ in. diameter cold-rolled shafting about 3 ft. long.

In order to guard against any spread of the building, overlapping lines of 8x12 in. cap timbers, running east and west, were placed under all needle beams and timbers. In addition, a number of tie bars running north south were used to connect the I-beam needles located on the same track. In this way distortion of building dimensions was prevented.

North Side of Building, Showing Method of Supporting Columns.

General Cribbing.—In order to properly shore up the building preparatory to moving, parallel lines of cribbing 4 ft. wide and about 6 ft. on centers, resting directly on the cement floor, were placed under the building. In this way the total load of the building was carried on fully 75 per cent of the building area. This resulted in a unit soil pressure of only ¾ ton per square foot and produced on evident settlement. The general cribbing, placed within the foundation walls in the new location, was of even greater extent, owing to the omission of certain interior walls. In addition to the general cribbing within the

building wall area a line of cribbing 10 ft. wide was placed adjacent to the east, west and south walls. The bottom layer of all cribbing was laid solid. In general, the cribbing built on the old site was of 6x6 in. and 8x12 in. material, and the material used on the new site was 6x8 in. and 7x16 in. An allowance of about 1 in. was made in the cribbing for settlement. From the foregoing it will be seen that two complete sets of cribbing were used. This arrangement saved at least two weeks in the time required for moving and avoided the necessity of moving forward an enormous amount of timber. In all, over 600,000 ft. of lumber were used for cribbing purposes.



East End of Building, Showing 90 ft. Timber.

Tracks and Rollers.—The general arrangement of walls and columns of a building dictates the number of tracks. In this instance 23 tracks were used and were placed in such a manner as to give the most uniform load distribution possible within practical limitations. In general, these tracks were placed from 5 to 8 ft. apart, and consisted of four or more lines of 65 lb. to 75 lb. standard railroad track rails in lengths varying from about 10 ft. to 30 ft. Before moving operations were commenced the top of all rails and cribbing was carefully leveled as a precaution against settlement and to insure a smooth-riding track.

For the purpose of actually moving the building over 2,000 steel rollers, spaced about 12 in. on centers, were used. Observations during moving indicated an average bearing area on the rail heads about ½ in. wide and probably caused an average bearing of about 4,000 lb. per linear inch on the rollers. Under these favorable conditions no cutting of the rollers occurred.

Cable and Capstan Arrangement.—Four capstans, each operated by two horses, were used as the motive power for moving the building. From each capstan a lead line of ¾ in. wire cable was carried down to and through a series of 25 blocks, 12 of which were movable and attached to the building and 13 of which were fixed blocks anchored to 20 ft. steel rails

driven about 15 ft. into the ground and braced against the new concrete foundation. Twelve in. single pulley steel blocks were used exclusively. These blocks were attached to the building on to the rail anchors with chains.

The capstans were of the single drum type, directly operated by a 4 in. by 6 in. hardwood sweep. The team was hitched to a point on the sweep about 10½ ft. from the center of the drum and under average conditions produced a pull of about 15 lb. on the cable for every pound of effort exerted by the team. At no time was the pull on the sweeps sufficient to cause any hardship and, it is believed, that the pull per team did not exceed 500 lb.

Rolling Friction.—Under ideal conditions the rolling friction of steel rollers laid on a perfectly level non-yielding track has been experimentally determined to be .015 or 1½ per cent of the supported load. Such an ideal condition is never possible in the field, nor is it possible to line up several thousand rollers perfectly square with the track. Obviously, this condition will materially increase the rolling coefficient. In addition, the friction load, from the pulleys, cables and capstans, must be considered and when all friction losses are summed up, will easily total up to .05 or even higher.

From calculations made, which were based on observations during moving, it is believed that the ratio between the pull of the teams and the weight of the building was about 5 per cent.

Speed and Distance of Moving.—The observed speed of the teams was two miles per hour, or about 3 ft. per second, and the best record made was a pull of 30½ in. in 4 minutes. The average speed of moving was 4 ft. per hour and the total distance through which the building moved was 85 ft. The actual moving time for the entire job was 20 hours, with a maximum distance moved in one day of 42 ft. 3½ in. In addition to being moved in a straight southerly direction, the building was turned slightly and moved 6¼ in. in a westerly direction. This secondary movement of the building was accomplished by slightly skewing the rollers.

The building was landed in its final location precisely on line at all corners, the final adjustment of rollers to accomplish this end being made principally in the last 20 ft. During the latter part of the moving program accurate checks on the movement of the building were made with a transit. This served as a guide for the adjustment of the rollers and assisted materially in the general accuracy of placement.

Public Service in the Building.—The building was not generally occupied during actual moving operations. It was, however, necessary for certain railroad employes to enter the building from time to time and for their convenience elevator, water, light and telephone service was maintained without interruption. These facilities were in no way damaged, proving conclusively that the building was moved without appreciable settlement. In so far as the moving contractor was concerned, full occupancy of the building would have in no way effected the methods employed or the time required for moving. The vacation of the building during moving operations was a precautionary measure taken by the railroad company and undoubtedly deserves credit.

Underpinning With New Brick Work.—As soon as the building had been landed in its final location and all cables and tackle removed, work was commenced underpinning the building with brick work, and bringing it to rest on its new foundation. This was accomplished by building up piers between adjacent "I" beams or timbers with common brick laid in 1:2 cement mortar. These piers were keyed up against the old brickwork by means of brick wedges cut on the job and driven in drum tight with wood blocking and hammers. The same method was also used to key up the "I" beams which suported the cast-iron columns on the north and west side of the building. These beams are completely encased in the new brickwork as a safeguard against corrosion.

New Concrete Piers.—In order to re-establish all interior columns on the new foundation, concrete piers varying in size from 2 ft. by 2 ft. to 2 ft. by 3 ft. have been built. The I-beam needles which supported the columns have been incorporated in the concrete and the overhanging ends cut off flush with an acetylene torch.

Regulation of Traffic.—As a protection to the public during actual moving, all vehicular traffic was sus-

pended on Michigan Avenue between 13th Street and 11th Place, also on East Roosevelt Road east of Michigan Avenue. In so far as possible pedestrian traffic was also regulated in the immediate vicinity of the building. The police forces of the South Park Commissioners, the city of Chicago and the railroad company co-operated in this work.

Amount of Material Used.—As an index of the amount of work involved, it will be interesting to summarize the amount of materials used:

7,500	cu. yd. excavation.
1,350	cu. yd. concrete work.
600,000	ft. timbers and lumber for cribbing.
1,500	bundles of shingles for shimming up.
36	long timbers ranging from 16 in. by 16 in. 60 ft. long to 20 in. by 20 in. 90 ft. long.
260	tons of I beams 18 to 24 in.
42	tons of steel rollers 36 in. long.
9	cars of rails, equal to 8 miles of track.
14,000	ft. steel cable.
102	snatch block pulleys.
1,400	jack screws.
5	two-horse capstans.
2,600	ft. ⅝ by 12 in. plates.

In so far as it has been possible to determine, the Dowie Building is the tallest building ever moved. Its weight is about 7,500 tons. The successful accomplishment of this difficult undertaking stands out as a distinctive engineering feat and a monument to the courage, skill and perseverance of the contractor. The work was done for the Illinois Central Railroad Company by Wm. H. Brown & Co. of Chicago, working under the direction of Mr. D. J. Brumley, chief engineer, Chicago terminal improvement; Mr. W. G. Arm, assistant chief engineer; Mr. C. H. Mottier, office engineer, and Mr. C. F. Fauntz, assistant engineer. The contractor's own organization handled all phases of the work. The writer acted as engineer and superintendent of construction.

Motor Vehicle Production.—In 1922 there were 2,659,000 motor vehicles made in the United States and Canada with a wholesale value of $1,789,638. Ninety per cent of them were passenger cars. During the first seven months of 1923 there were produced 2,127,000 passenger cars and 227,000 trucks. Registration of motor vehicles in the United States on July 1, 1923, was 13,002,000, of which 11,571,000 were private passenger cars. Of the passenger car registration of 10,800,000 at the end of 1922, it is estimated that 3,200,000 were owned by farmers.

Operating Costs of 1-Man and 2-Man Cars

Data From Electric Railway Companies Operating Each Type of Car Exclusively Analyzed in AERA

By H. C. HICKOCK

General Engineer, Westinghouse Electric & Manufacturing Co.

Data of American Electric Railway Association.—The American Electric Railway Association has obtained valuable data regarding the operating costs of a number of railway companies operating exclusively two-man cars, or exclusively one-man cars over a period of two years. These data are shown in two comparative tables, I and II, for the years 1922 and 1921 respectively. There are some 350 railway companies reporting to the A. E. R. A., and the comparison is based on 21 companies operating two-man cars exclusively, and 24 comcompanies operating one-man cars exclusively.

It is interesting to note that in the compilation of data received from the 350 companies reporting, there were only 26 companies which operate exclusively two-man cars.

While the problem of reducing operating costs by changing from two to one-man operation is one which must be solved on the merits of the particular case, a general comparison shows exclusively the trend of the costs. The costs in Tables I and II have been segregated according to the following Interstate Commerce Commission accounts:

Maintenance of Way and Structures.

Maintenance of Equipment.

Maintenance and Operation of Power Plant.

Conducting Transportation.

Traffic.

General and Miscellaneous.

Undistributed.

The Saving in 1-Man Car Operation.—The saving due primarily to one-man operation is shown under the account for "Conducting Transportation," and as may be noted from the tables, shows the difference in cost for this one account to be about 40 per cent less for the one-man operation. This, of course, results chiefly from a

Table I

Operating Expenses of 21 Electric Railway Companies Operating Two-Man Cars Exclusively and of 24 Companies Operating One-Man Cars Exclusively

	1922 Cents Per Car Mile		Percentage
	2-Man Cars	1-Man Cars	Difference
Maintenance of way and structures	4.32	2.69	*37.8
Maintenance of equipment	3.51	2.61	*25.7
Maintenance and operation of power plant	6.28	2.79	*55.5
Conducting transportation	14.81	8.26	*44.2
Traffic	0.11	0.12	†9.1
General and miscellaneous	4.58	3.47	*24.2
Undistributed expense	0.39	0.20	*48.7
Total operating expense	34.00	20.14	40.7
Car mileage	59,283,962	13,972,686	

*Decrease.
†Increase.

Table II

	1921 Cents Per Car Mile		Percentage
	2-Man Cars	1-Man Cars	Difference
Maintenance of way and structures	4.94	2.63	*46.8
Maintenance of equipment	3.78	2.77	*26.7
Maintenance and operation of power plant	6.23	3.33	*46.6
Conducting transportation	16.18	9.21	*43.1
Traffic	0.15	0.11	*26.7
General and miscellaneous	4.60	3.74	*18.7
Undistributed expense	0.53	0.21	*60.4
Total operating expense	36.41	22.00	*39.7
Car mileage	57,336,002	14,047,318	

*Decrease.

reduction in number of car operators to one-half, and the custom of paying the operators of one-man cars approximately 10 per cent more per hour than the men on two-man cars.

The difference shown for the other accounts are those which accompany the introduction of one-man cars due to the lighter weight and type of these modern cars. Every railway man appreciates the fact that the cost of power, and the maintenance of way and structure decrease with the introduction of lighter weight cars, also that the cost of maintaining car equipment will be less with new, lightweight, modern equipment. The percentage differencs which may be expected from these accounts, based on the compilation, are shown in the tables.

Due to the great variety of types of one-man and two-man cars, it is difficult to compare the above operating cost accounts otherwise than between one and two-man operation. Regarding the types of cars used in the comparison, there is available only slight information on the one-man class. In all, this class represents 370 cars, and of these, no information on 135, or 36 per cent, of the cars is given to the particular type; 111, or 30 per cent, are of the Birney type; 20 per cent cover converted, single truck cars, and 13 per cent cover converted, double truck cars. Therefore, at least one-third of the number of cars represent cars which have been converted, and which do not lend themselves to all the savings possible with the specially built, modern, one-man cars.

Also, the tables are not on a strictly comparable basis with respect to one-man cars, due to the large differences in the car mileage. With a greater car mileage, fixed charges form a smaller percentage of the total operating expenses. It will be noted that the car mileage of the two-man cars for the two years, 1922 and 1921, is more than four times that of the one-man car mileage.

The above two factors in the comparison make the savings resulting from the possible adoption of the modern one-man cars conservative.

These data indicate conclusively the tendency to adopt one-man operation, and that, where applicable, these cars very appreciably reduce the operating expenses incident to operation with two-man cars. A reduction of 40 per cent in the operating expenses may be considered as reasonable, and individual cases may show the savings to be considerably greater.

Construction of Street Railway Track in Paved Street

Proposed Specifications* Submitted Nov. 12 at 29th Annual Convention of American Society for Adoption as a Recommended Specification

These specifications are intended to cover the construction of electric railway track in paved city streets. It is obvious that no general specification can be prepared for such work to cover all special types of track construction, or to meet special conditions. The scope of these specifications has therefore been limited to an expression of the fundamental principles which should be followed out in constructing track in paved streets.

I. Excavation

101. The space to be occupied by the tracks shall be excavated to a depth of ..... inches below the finished grade of the top of rail. All soft or spongy material shall be removed and replaced with sound material, or where this is not practicable, such other steps as may be necessary shall be taken to provide a proper support for the track.

102. Where necessary and where practical to do so, the subgrade shall be thoroughly rolled with a roller weighing not less than 10 tons. Either a 3-wheel or tandem type roller may be used. Where, the use of a roller is not considered practical, compacting of the sub-grade may be accomplished by tamping.

II. Sub-Soil and Surface Drainages

Sub-Surface Drainage: 201 (a). Where the nature of the sub-soil does not provide sufficient natural drainage, artificial sub-soil drainage shall be provided.

(b) Where artificial sub-soil drainage is required, this shall be effected by laying 4 or 6 in. tile pipe in a trench, surrounded by crushed stone, clean gravel, cinders or other suitable porous material, the drains to be laid either under the center of the track or midway between the two tracks, or at such other locations as may be determined by the character of the soil and the extent of the drainage requirements.

(c) Where storm water sewers are available, sub-soil drains should be connected to same by means of vitrified tile pipe of suitable size.

Surface Drainage:

202. Track surface drains of approved type shall be installed at all low points in the track grade and at such other locations as conditions may require, and connected to the sewer if same is available by means of vitrified tile pipe, or provided with some other suitable outlet. They shall preferably be made of cast iron, designed to fit the particular type of rail and track gage where used, and shall be provided with removable iron grading type covers so as to facilitate cleaning of drain box.

III. Types of Foundation

(A) Plain Ballast Construction:

301. Where the track is of the "plain ballasted type," such ballast shall preferably consist of either clean, hard, durable crushed stone, crushed slag, clean gravel, cinders, or other suitable material. Where the character of the sub-soil is suitable, the use of the natural ballast material encountered in the trench excavation may be permitted for this purpose.

Distribution and Rolling:

302. (a) Ballast shall be evenly distributed under the ties so that after the track has been surfaced and the ballast tamped and compacted, it shall have a minimum depth of ..... inches. Where practical to do so, the ballast should be thoroughly rolled with a roller weighing not less than 10 tons before the ties are placed in the trench.

(b) The best results will be obtained from the use of a ballast which will provide a maximum density after tamping, such as the run of the crusher with dust removed.

*Approved and recommended for adoption by the Committee on Specifications for Street Railway Paving and Track Construction, Charles E. DeLeuw, chairman, and by the Way Committee of the American Electric Railway Engineers' Association, in collaboration.

(B) Concrete Sub-Ballast Construction:

303. Where a "concrete slab sub-ballast construction" is used, such concrete shall be laid upon the sub-grade prepared as described in Sec. 101 to 201 (c), inclusive, to a depth of ..... inches. The concrete shall conform to the A. S. M. I. specifications for concrete for pavement foundations.

304. Track shall be laid and surfaced on this concrete slab, the ballast used shall consist of clean, hard, durable crushed stone, gravel, slag, or other suitable material, and shall be thoroughly tamped under the ties. The size of the ballast should preferably be run of the crusher up to 1 in. with dust removed.

(C) Solid Concrete Construction:

305. Where track is to be constructed with solid concrete construction, or rigid type, the sub-grade shall first be prepared as described in Sec. 101 to 201 (c), inclusive. The placing of the concrete shall follow immediately after the surfacing and lining of the track, and the concrete shall be brought to a height of ..... inches below the top of the rail and shall coincide with the grade established for the top surface of the pavement base. Concrete below and around ties and rails shall be thoroughly rammed and tamped. Care shall be taken in tamping concrete to see that the surface and line of the track is not disturbed. In no case shall the ends of the ties be covered by a board while placing concrete. The concrete shall conform to the A. S. M. I. specifications for concrete for pavement foundations.

IV. Rails

401. The rails used, if of a standard T-rail section, shall comply with the Standard Specifications for Carbon-Steel Rails (identical with A. S. T. M. Spec. A1-14 except for addition of Sec. 506 covering milling of rail ends) of the American Electric Railway Engineering Association (Wr 7a) as adopted October, 1922. Rails of the plain girder (high T-rail), grooved girder, tram girder, or guard type, shall conform with the Standard Specifications of the A. E. R. E. A. (Wr 2d) revision of October, 1922, for open hearth steel girder rails.

V. Rail Joints

Splice Bars:

501. The rail joints shall be modern bolted, riveted or welded joints. In case of bolted type joints, not less than four bolts shall be used of sufficient strength to insure drawing and holding the splice bars tightly in place. Splice bars shall conform to the requirements of the Standard Specifications of the A. E. R. E. A. for one of the following grades, according to the purpose for which the splice bars are to be used:

(a) Low carbon steel splice bars—Wm 9a.
(b) Medium carbon steel splice bars—Wm 10a.
(c) High carbon steel splice bars—Wm 11a.
(d) Extra High carbon steel splice bars—Wm 12a.

Welded Joints:

502. The term "welded joints" is intended to cover joints made by any of the following processes:

(a) Cast weld.
(b) Lorain bar weld, resistance type.
(c) Thermit weld.
(d) Lorain butt-weld.
(e) Arc weld; either carbon arc or metallic arc.

Riveted Joints:

503. The term "riveted joint" is intended to cover all joints where the splice bars are secured by means of rivets instead of bolts. Holes for rivets should be reamed to insure tight fit and bearing after the rivets are driven.

Grinding Rails at Joints:

504. The surface of the rail head shall be carefully ground at the joint in order to insure a smooth running surface and to overcome slight variations in rail sections or splice bars. Care shall be taken in all joints to butt the rail ends tightly before making the joints.

VI. Bonds

601. Where joints other than the welded type are installed, copper bonds of approved design and of sufficient capacity to insure a proper return, shall be installed. Cross bonds connecting the two rails shall also be installed at suitable intervals in order to prevent differences in potential between the rails. Supplementary cable shall be run through or around all special track-work and thoroughly bonded to the unbroken rails on each side of the special trackwork.

VII. Rail Fastenings

Spikes:

701. The rail shall be brought to proper gage and fastened securely to ties by means of either cut, rolled or screw spikes. Where screw spikes are used, the tie should preferably be bored in the shop by a boring machine which bores all the holes at one time, in order to insure accuracy in gaging the rails. The use of clips with screw spikes is permissible.

Tie Plates:

702. Where tie plates are used, the size, type, and weight will depend on the weight of equipment, dimension of rail base, physical characteristics of wood used for ties, and tie spacing, it being essential that the total load on a tie at the rail bearing point, shall be kept within the safe allowable limit against crushing of the wood fibres at right angles to the grain.

Tie Rods:

703. Where conditions are such as to make it advisable, tie rods or rail braces of suitable design may be used in order to assist in holding rails to gage. Spacing of tie rods shall not be less than 6 ft. nor more than 10 ft. Where rail braces or brace tie plates are used, they shall be installed at intervals of not to exceed every third tie.

VIII. Ties

Untreated Group:

801. The following woods may be used for ties untreated:

Group Ua—Heart white oaks
Heart black locust
Heart black walnut
Group Ub—Heart Douglas fir
Heart pines
Group Uc—Heart cedars
Heart cypresses
Heart redwood
Group Ud—Heart catalpas
Heart chestnut
Heart red mulberry
Heart sassafras

Treated Group:

802. The following woods may be used for ties when properly treated:

Group Ta—Ashes
Hickories
Sap black locust
Honey locust
Red oaks
Sap white oaks
Sap black walnut
Group Tb—Sap cedars
Sap cypresses
Sap Douglas fir
Fir
Hemlocks
Larches
Sap pines
Sap redwood
Group Tc—Beech
Birches
Cherries
Gums
Hard maples
Group Td—Sap catalpas
Sap chestnut
Elms
Hackberries
Soft maples
Sap mulberries
Poplars
Sap sassafras
Spruce
Sycamores
White walnut

General Specifications:

803. Ties shall be manufactured from sound, live timber and shall be free from any defect that may impair their strength or durability as cross-ties, such as decay, large splits, large shakes, large or numerous holes or knots, or grain with slant greater than 1 in 15. Ties for the use without preservative treatment shall not have sapwood wider than one-fourth the width of the tie for a distance of 10 in. on either side of the center of each rail bearing. Such ties shall be designated as "heart" ties. These with more sapwood shall be designated as "sap" ties.

Dimensions and Permissible Variations:

804. Ties should (except in the case of narrow gage track) conform to the following dimensions: Length 8 ft., width 8 in., depth 6 in. Variations from the above dimensions will be allowable as follows:

	Hewn (4 Sides)	Poles (Sawed or Hewn Top and Bottom)	Sawed (4 Sides)
Depth not less than	6 in.	6 in.	6 in.
Depth not more than	7 in.	7 in.	7 in.
Face not less than	7.5 in.	6 in.	8 in.
Length	8 ft. to 8 ft. 2 in.	8 ft. to 8 ft. 2 in.	

Spacing:

805. Wood ties shall be spaced not less than 22 in. nor more than 30 in. on centers.

Preservative Treatments:

806. Where wood ties are treated, this preservative treatment shall be made in accordance with the recommended specifications for preservative treatment of timber of the American Electric Railway Engineering Association (Wm 8b). The oil used shall conform to the requirements of the recommended specifications of the A. E. R. E. A. (Wm. 8b) for that grade.

Substitute Ties:

807. Where steel ties or other form of substitute ties are used, care shall be taken to see that the rail is securely clipped and bolted to same. They shall be laid on the centers suitable to the design of the ties.

IX. Pavement Base

A. S. M. I. Specifications to Control:

901. Except in the case of solid concrete track construction, when the track has been properly lined and surfaced, the paving base, where type of pavement requires same, shall be laid. It shall be of concrete which shall conform to the requirements of the A. S. M. I. for concrete pavement foundation.

Depth Depends on Pavement:

902. The depth of the concrete paving base shall depend on the type of paving to be laid, and in no case shall it extend below 1 in. above the bottom of the tie.

X. Rail Plaster

1001. Immediately preceding the laying of the pavement, the space along both sides of girder rail webs between the head and under side of the lip and the base, shall be filled with a plaster composed of 1 part Portland cement to about 3 parts sand or other suitable material in order to properly support the paving laid next to the rails. A mastic may be substituted for this filler, consisting of asphaltic concrete binder.

XI. Pavement

1101. The pavement shall be laid in accordance with the specifications of the A. S. M. I. for the type of pavement to be installed. Where practicable to do so, vehicular traffic should be kept off the track until the paving joint filler has had sufficient time to set thoroughly.

Railroad, City and Power Co. Propose $1,500,000 Water Main

A plan is reported under consideration whereby the Chicago, Burlington & Quincy R. R. and the Illinois Power and Light Co. would construct a pipe line from Burlington, Ia., to Galesburg, Ill., at a cost of $1,500,000 to furnish the railroad, the power company and city with water. The railroad would contribute $750,000, the public utility company $250,000 and the city of Galesburg $500,000.

Method of Renewing Track Pans

During the past season six track pans on the western division of the New York Central R. R. were renewed. We are indebted to the New York Central Lines Magazine for the following information regarding the handling of this work.

The track pans consist of a metal trough about 19 in. wide and 2,000 ft. long, laid in the middle of the track. A scoop located under the engine tender is dropped into this trough while the train is in motion and the momentum of the train forces the water up into the engine tank.

In renewing these track tanks the tracks are not taken out of service, and as there are from 75 to 100 trains moving over the plant each 24 hours, it is difficult to carry on the work.

When work was first started on renewing the pans it required from 30 to 35 hours to take out the old pan and install the new one, but as the gang became more familiar with the work the time was gradually lessened.

The best time was made in renewing the westbound pan at Lydick. The pan was taken out of service at 8 a. m., Aug. 6, and the new pan was put back in service at 1:30 p. m., Aug. 8. After deducting dead time due to trains stopping over the pan to take water from the standpipe and movement of trains on adjacent tracks, it was found that the renewal was made in just 19 actual working hours.

The work was handled in the following manner:

The carpenter gang and the steam derrick were shipped to Lydick before the pan was taken out of service, and distributed the new pan along the track. After the old pan was taken out of service an oxyacetylene welder was started cutting the pan into about 30 ft. lengths. As fast as a section of the old pan was cut it was removed by the derrick and a new section set into place.

Two or three riveting gangs of three men each were started riveting the new sections together, and the work progressed in that way the entire distance of 2,000 ft. The inlet and outlet connections were then made and the pan was filled and turned over to the operating department.

Supervision of Railway Bridge and Building Forces

Duties and Responsibilities of Supervisor Outlined in Paper Presented Oct. 17 at 33rd Annual Convention of American Railway Bridge and Building Association

By GEORGE W. REAR
Engineer of Bridges, Southern Pacific System

The writer intends to set down only a few thoughts in regard to the supervisor's responsibilities, etc., with the hope that with such elaboration as other members may make from time to time, some uniformity of practice will develop for the betterment of the service. Most rule books designate the supervisor's duties as follows:

"Supervisors of bridges and buildings report to (a superior) and under him are responsible for the inspection and safe maintenance of all structures, etc."

This rule contains the secret for the successful supervisor—it can be said without fear of contradiction that every supervisor who has been made responsible and who assumed the responsibility has been successful, the failures being among those who were denied full responsibility or who were not able to assume it.

Supervisor Should Know Peculiarities of All Structures in His Territory.—The supervisor has many duties and responsibilities and at the outset we may assume that he will be short of help and will have to exercise the greatest economy to perform the work with the money that may be available. He should become so familiar with all the structures on his territory as to know all their peculiarities without reference to records. Bridges and culverts are seldom perfect, stations are inadequate, water and fuel supply heavily taxed, especially during the periods of heavy traffic. Bridges and culverts may not be able to take care of freshets and floods properly, drift may be troublesome, or the traffic over them may be so heavy as to make almost continuous repairs necessary. All of these peculiarities should be well known to the supervisor, so proper measures can be taken to protect them in case of necessity.

The supervisor should be responsible for the regular inspection of structures and should inspect them in person at least once each year. Even on large and busy divisions, no obstacle should prevent him from seeing his structures every year. The work of inspection requires experience and sound judgment, especially for those structures that are approaching the time for replacement, due either to physical condition or lack of capacity. Lack of capacity may be either a lack of sufficient size or stability to withstand floods, or of capacity to carry traffic with a reasonable margin of safety.

Records of Structures and Work Records.—The supervisor usually is not responsible for the design of structures but he is responsible for their maintenance in safe condition, and to the standard of maintenance in force on his railroad. Reduced income may make it necessary at times to delay improvements and extensive rebuilding, but unsafe conditions cannot be tolerated under any conditions. He is responsible for proper records of the structures under his charge, even if such records are kept in other offices. He should have the most exact and complete information as to matters of foundation, location of pipe lines, flood damage, etc., as he is the first to be called on for such information when it is required. It is probable that this feature is quite generally neglected, owing to pressure of other work and lack of sufficient help, but it should not be, as it is a duty he owes to his successor and to his railroad.

The supervisor should keep records of the work that will be necessary for some months in advance, and on a well organized division it should never become necessary to make rush or emergency repairs, except of course as the result of washout or accident. Such a program of work, and its authorization in ample time, enables the supervisor to plan his work and avoid moving gangs back and forth over the same territory. This is especially true with those railroads where gangs cover large mileage, as is the custom on western railroads. In spite of planning, much time is lost by gangs traveling from place to place, but efforts should be made to reduce it to a minimum.

The supervisor should have sufficient organization to take care of the work on his territory, but he can expect to be shorthanded the same as all other departments and will find it

necessary to get the utmost service out of each employe if he is to keep his head above water. Having neither men nor money enough to take care of his work is not as serious a matter as it appears, for it has a tendency to bring forth hidden resources and results in greater economy.

The Supervisor Should Be the Boss.—Owing to the variation in lengths of divisions and the work thereon, it is impossible to outline what forces the supervisor should employ, but whether they are many or few they should have only one boss, and that should be the supervisor. There should be no let down to discipline whereby others give instructions or orders to men employed under the supervisor. All instructions or orders should be handled through the supervisor, if he is to retain the respect of his men and be responsible for their work. The supervisor should therefore earn the respect of his men by fair dealing and endeavor to make them railroad men and not temporary employes.

The relationship between the supervisor and his men will not be gone into in detail at this time, except to state that the supervisor should realize that his employes are intelligent, and many probably know nearly as much about the details of the work as he does. Realizing this will save him much worry, and while it will not relieve him from the necessity of giving definite instructions as to what is to be done, it will relieve him of much petty detail.

The successful supervisor becomes a very important part of the divisional organization, and his resourcefulness and experience are a great satisfaction to his superiors when they can place entire confidence in him, especially in cases of emergency. The successful supervisor works in close contact with the other departments and one of the earmarks of a good supervisor is the willingness of all the other departments to rally to his assistance when required. Close co-operation with the supply department results in much good, as many times suitable material can be found in stock, avoiding purchases of material which otherwise may be ordered without knowledge of what is on hand.

Supervisors should, as far as possible, keep the supply department advised of future requirements, especially if out of the ordinary in character, as this may have the effect of getting better delivery when the material is required. Co-operation and good fellowship between all departments, and between the employes o the same department, take a great deal of the burden out of the work and make the service enjoyable and life worth living.

Qualifications of Successful Supervisor.—No set rule can be set down for the cultivation of men for the position of supervisor, as successful men have sprung from a great variety of conditions, but if we were to consider the qualifications necessary they might be put as follows:

First: I would put "character"; that is, the supervisor should be a good, upright, clean living citizen of his community, respected by his neighbors and associates.

Second: He should be a good business man, as it will be necessary for him to handle many business affairs for his employer.

Third: He should be a natural engineer, born with the constructive instinct, as he will be responsible for work performed under all the mechanical trades, and it is hardly possible to become familiar with all of them.

Fourth: He should be even tempered, fair-minded, without prejudices as to religion, race or politics, so he can treat his subordinates properly, and give them a little better treatment than the letter of the law prescribes, thus earning their loyalty and respect.

Fifth: Education—a good education is a great help to the supervisor, especially in these days of complicated reports, etc. The successful supervisor is never fully educated, but the more book learning he can bring to the job the easier it will be to continue the process of education, which will only be completed at his retirement.

The supervisor being the executive head, business manager and chief engineer of his department, must keep himself informed and up to date in all developments pertaining to construction work involving the use of steel, wood, masonry, plaster, concrete, painting, etc. He must familiarize himself with all construction apparatus and labor saving devices, and as far as possible furnish such tools for use on his work.

Concrete Tanks for Railway Water Service

Abstract of a Paper Presented Oct. 18 at 33rd Annual Convention of the American Railway Bridge and Building Association

By C. R. KNOWLES
Superintendent Water Service, Illinois Central Railroad

The first concrete water tank built in the United States was a standpipe constructed at Little Falls, N. J., in 1899. What was probably the first concrete tank used in railway water service was constructed ten years later by the Spokane, Portland and Seattle railroad. Other railroads have constructed concrete water tanks from time to time until at present about 25 are in service on American railroads.

General Design Features of Railroad Concrete Water Tanks.—Concrete water tanks constructed on American railroads to date have followed four general designs, so far as the tower, floor and walls are concerned. These designs are briefly as follows:

1.—The standpipe type of tank with the floor or bottom of the tank at or near the top of rail and utilizing the entire height of the structure for the storage of water.

2.—A cylindrical shell forming both the tower and walls of the tank with a diaphragm or floor placed at the desired height in the shell with a central pier or column to assist in supporting the floor. In some cases the central column has been eliminated, the floor being made self-supporting in the center.

3.—A cylindrical shell as above, forming both the tower and walls of the tank and a hemispherical bottom.

4.—A tower consisting of columns and a floor system of beams supporting a flat bottom and straight cylindrical walls.

Concrete water tanks now in service throughout the country represent almost as many designs as there are tanks in service. Apparently in many cases almost as much attention is devoted to their appearance as to their utility. This is particularly true of tanks designed for municipal and other public water supplies. While the question of appearance has not been entirely ignored in the construction of concrete railway water tanks, with a few exceptions the concrete tanks in service are no more pleasing to the eye than the familiar steel or wooden water tanks, although the attractive appearance of the concrete tank is one of the principal arguments advanced in its favor.

Concrete Water Tanks of Frisco Ry.—The tanks at Marshfield and Cuba, Mo., on the St. Louis-San Francisco Ry., are typical of the first named or standpipe type of tank. These tanks are of simple cylindrical form 39 ft. 6 in. high above the floor and 34 ft. inside diameter, affording a total interior capacity of 272,000 gal. The bottom of the Marshfield tank is only 6 ft. above the top of rail, so that the water in the lower portion of the tank is not available for use, reducing the actual effective capacity to 220,000 gal.

A 100,000 gal. concrete tank constructed at Springfield, Mo., in 1916, also on the St. Louis-San Francisco, is typical of the second design of tank listed above. This tank consists of a cylindrical shell 55 ft. high by 25 ft. outside diameter, supported on a concrete slab 31 ft. in diameter. A floor or diaphragm is placed in the shell at a height of 24 ft. above the ground and the water is confined to the upper 31 ft. of the structure, the lower portion of the tank serving only as a support for the upper part. A central column or pier is introduced to assist the walls in supporting the floor, and a 6 in. inlet and outlet pipe passes through the center of this column. In the construction of the Springfield tank an effort was made to construct the wall of the tank proper integral with the floor, with the result that cracks developed subsequent to the completion of the tank.

In the construction of the Cuba and Marshfield tanks—which were built later—the walls were cast independent of the floor with special provisions for joints between to be filled with asphalt.

Tanks of Duluth & Iron Range R. R.—The tanks at Biwabik, Tower Junction, Fairbanks and Robinson, Minn., on the Duluth & Iron Range R. R., are typical of the second type of tank with a flat slab diaphragm or bottom

in the walls of the tank above ground without the central support.

A concrete tank erected on the Norfolk and Western at East Radford, Va., is typical of the third type with hemispherical bottom. The lower portion of this shell is 31 ft. 6 in. in diameter and the hemispherical bottom is placed in the tank at a height of 24 ft. above the rail, the over-all height of the tank being approximately 56 ft. 6 in.

Concrete Tank at Pecos Viaduct.—A concrete tank constructed by the Southern Pacific Lines in Texas at the famous Pecos viaduct is representative of the last-named type, with tower constructed of columns. This tank is described in the Railway Maintenance Engineer for December, 1922, as follows:

"One of the water supply tanks is a reinforced concrete tank of 100,000 gal. capacity located 200 ft. east of the viaduct. This tank is supported on five columns 2 ft. 6 in. square, resting on spread foundations; a system of beams and girders framed into the top of these columns support the floor of the tank which is 30 ft. in diameter and 20 ft. high. The tank was poured in two stages, the first stage completing the floor and columns and the second stage the shell which is separated from the floor by a sliding joint protected with copper sheeting $\frac{1}{16}$ in. thick, covered on both sides with graphite and sealed with asphalt cement."

Tanks Built on Distinctive Lines.—Other tanks have been built on railroads which have followed distinctive lines. This is particularly true of the Central of Georgia which has constructed concrete tanks at Savannah and Millen, Ga. The Savannah tank, the highest structure of this kind in the world, with an over-all height of 188 ft., was completed in March, 1911. The structure consists of a supporting tower and two tanks. The upper tank, with a capacity of 100,000 gal., is reserved exclusively for fire protection, while the lower one, with a capacity of 50,000 gal., is for general service. As stated previously the shaft is 188 ft. high and 30 ft. outside diameter at the ground line. This diameter is gradually diminished, becoming 25 ft. at a distance of 75 ft. above the ground and continuing cylindrical from that point to the top. The walls are 9 in. thick at the bottom and taper to a thickness of 7 in. at a height of 75 ft. above the ground which thickness is continued for the remainder of the height. The structure is supported on a foundation, consisting of 117 piles 40 ft. long. The floors of both tanks are hemispherical in form.

The Millen, Ga., tank has a capacity of 150,000 gal. and is similar in design to the Savannah tank except that it has an over-all height of only 57 ft. The shaft or tower is 35 ft. in height with a diameter diminishing gradually from 31 ft. at the top of the foundation to 24 ft. at the bottom of the tank. The bottom is hemispherical in form and is 9 in. thick. The diameter of the tank proper is increased from 25 ft. at the bottom of the tank to 30 ft. at a point 12 ft. above the bottom, continuing cylindrical from that point to the top. The shell of the supporting tower as well as of the tank itself is only 8 in. in thickness and on account of its thinness extreme care was used in placing the concrete. Integral waterproofing was used in the concrete and the inside of the tank was given a treatment of pitch upon completion. The first step in the construction of the Millen tank was the erection of a tower in the center of the tank, the concrete for which was hoisted in a bottom-dump bucket and spouted into the form. The circular wall forming the tower of the tank was first constructed with an offset at the springing line of the floor dome. The floor dome was then poured, leaving only the hole through which the tower extended. Upon the completion of the walls of the tank the tower was removed and the hole poured, the edges of the hole being inclined so that the weight of the water tended to tighten the construction joints.

The Baltimore & Ohio has constructed a tank of the standpipe type at Fairmont, W. Va., which is used as a water treating plant. The total height of this tank above the foundation is 46 ft., and the tank has an inside diameter of 32 ft. The walls of the tank are 16 in. thick and are cast integral with the floor of the tank.

Demountable Reinforced Concrete Tank.—A demountable reinforced concrete water tank with the tank itself cast in the form of staves of a barrel, constructed on the Western Railway of Havana, was described in the Railway Maintenance Engineer of February, 1920, as follows:

"The concrete framing supporting

the floor of the tank is cast in two equal halves which are bolted together with ⅞-in. bolts at regular intervals. The floor is cast with recesses extending around its outside diameter, the recesses being sufficient to permit the insertion of the lower ends of the tank staves and two ¾-in. square reinforcing bars.

"The floor is supported on 13 rectangular columns, 12 of which are arranged on the circumference of a circle which has for its center the 13th or main column. All of the supporting columns rest on concrete piers. The upper ends of the upright supports are fastened to the floor of the tank by means of bolts which pass through loops formed by the reinforcing rods of the floor. The radial supports, which branch out in the shape of braces from the main or center column, are provided with cored holes for the insertion of the bolts to secure the upper end of the support to the tank floor.

In erecting the staves of the tank the lower ends are set into the groove provided in the floor after the inside face of the joint has been well painted with pitch. Two reinforcing bars are then placed in the groove outside the staves and the groove is filled with concrete, after which the inside joint is caulked with oakum. After job is completed the inside and outside of tank are painted with coal tar, which is followed with a coat of pitch.

The hoops retaining the staves are ¾ in. square iron with two turnbuckles to a hoop. They are spaced in accordance with the loads at the respective points and are all of the same cross section."

Lack of Uniform Design Disadvantage.—The lack of a uniform design of concrete water tank that would overcome the existing faults resulting in cracks in the concrete, seepage and other leakage has probably reacted against the concrete tank as much as anything else. A standard uniform design of tank would undoubtedly result in materially reducing the cost of construction and would bring this type of tank into closer competition with tanks of other types. The concrete tanks that have been erected represent nearly as many different designs as there are tanks, with the result that it is almost impossible to make a comparison of tanks under varying conditions of service, while an intelligent estimate of costs is practically out of the question.

Some designs have apparently overcome one fault only to develop another. Practice on different railroads varies widely as to design of tower and tank, thickness of floor and wall, reinforcing and method of placing, forms, mix, aggregate and method of construction and until some design of tank is developed and adopted that will be uniform, at least in general principles, progress will necessarily be slow.

Permanent Location of Tank.—In the development of a railroad property it is frequently necessary to move water tanks, and from the nature of their construction concrete tanks cannot be moved. Thus, the permanence of the concrete tank, while used as the principal argument in its favor, is at the same time one of the principal objections to its use in many cases, for while it is undoubtedly permanent in every sense of the word, there is always a question as to the permanence of the railroad, in location at least, and changes in road may take place that will result in the concrete tank becoming useless within a few years. Where a steel or wooden tank could be moved to a suitable location at considerably less than the cost of a new tank, the concrete tank is not only useless but will probably entail considerable expense for wrecking.

As an example of the changes that occur in the location of water tanks, a study of 540 tanks in service on a middle western railroad shows that the location of only 56 has remained unchanged in 25 years. While of course many of these have been renewed on account of age it has been advisable to change their location in frequent instances. This serves to emphasize the necessity for the careful selection of a site that will not be affected by future changes and improvements. Very few railroad water stations can be considered permanent because experience has shown that operating conditions are constantly changing, requiring frequent and unexpected changes in yards and tracks.

Therefore, the erection of a concrete tank is inadvisable unless the location is known to be permanent beyond the possibility of a doubt. Thus, in a great many cases where the territory traversed by the railroad is not fully developed or where the water stations and line of road are not firmly established a concrete tank

cannot be considered as a serious competitor of steel and wooden tanks.

The difficulty of obtaining a permanent location for a tank that will not be affected by changes in road or structures is probably the most serious objection to the extensive use of concrete tanks on railroads.

Cost of Concrete Tanks.—It is extremely difficult to obtain any cost data on concrete railway water tanks that are applicable to average conditions or that can be used as a basis for estimates or comparison with other types of tanks on account of the wide difference in designs and the limited number of tanks in service.

It is obvious that concrete tanks will cost more at the present time than steel or wooden tanks of the same capacity, not only on account of the materials involved and the amount of labor required for construction but also on account of the expensive form work which is in some cases specially designed for each job and adds very materially to the cost. The additional foundation required for a concrete tank is also a factor affecting the increased cost over tanks of other types, as the weight of the concrete tank exclusive of the water, is much greater than that of a steel or wooden tank. Factors affecting the cost of concrete tanks other than design are the thickness of wall and the character of concrete, such as mix, aggregate, etc. The amount of reinforcing required in the construction of a 100,000-gal. tank varies in different designs from 14,000 lb. to 26,000 lb.

From the best figures available the cost of a 100,000 gal. concrete tank erected prior to 1918 ranged from $5,000 to $7,500. In all probability these tanks would cost considerably more at the present time. Estimates received in 1920 from a contractor making a specialty of concrete tanks placed the cost of a 100,000 gal. tank of the cylindrical type with an overall elevation of 62 ft. between $8,000 and $10,000. The cost of a 100,000 gal. steel tank varies from $5,000 to $5,500 and of a wooden tank of redwood or cypress from $4,000 to $4,500.

The cost of concrete tanks is undoubtedly a factor which has contributed in no small part to limiting their construction on railroads. The question of cost will continue to have its effect upon the construction of concrete tanks until uniform designs and methods of construction are developed to such an extent that the cost will be reduced to compare more favorably with tanks of other types.

Conclusions.—It has been demonstrated conclusively that it is possible to produce concrete that is impervious to water, at least to the extent required in a railway water tank.

No inherent fault has developed in concrete that would make it unfit for the storage of water and there does not appear to be any reason why it should not prove satisfactory for this purpose if the tank is properly designed and constructed.

There are certain features in the construction of concrete tanks that will have to be given further consideration, however, before the concrete tank can be considered with tanks of other types, chief among which is the question of design. There is no uniformity in design in tanks that have been constructed, which has kept the cost of tanks at such a high point that they have not been considered seriously in comparison with steel and wooden tanks. It is not the thought that a standard design of tank should be adopted to fit all conditions, but certain principles of design will have to be agreed upon before the concrete tank will come into general use. Such a design should be aimed to bring the cost of the tank into competition with other types of tanks and provide against leakage, both through porosity or through shrinkage or expansion of the concrete, resulting in cracks.

The difficulty in establishing a location that will be permanent and that will fit in with the development of a railroad property is one of the principal obstacles to the adoption of concrete tanks and their construction will be limited to installations where the location is known to be permanent beyond a doubt.

The first cost is another serious handicap to this type of tank as the investment required does not compare favorably with that of other types of tanks in spite of their acknowledged permanence and low cost of maintenance.

While the concrete tank will no doubt in time find its place in railway water service, it has not yet been developed to the extent that it can be recommended for general use. This statement is not based upon any specific objection to concrete as a material for water tanks as no fundamental objection may be offered against its use for this purpose.

Highway Transport as Aid to the Railroads

Abstract of Address Presented Nov. 6 at Joint Session of North Central Division of National Highway Traffic Association and Michigan State Good Roads Association

By ARTHUR H. BLANCHARD

President National Highway Traffic Association and Professor of Highway Engineering and Highway Transport, University of Michigan

What is the present attitude of railroad officials in the United States towards the development of highway transport? The answer is not a simple one to formulate, as many diverse opinions have been expressed in words and actions. Some of our railroad officials appreciate the intrinsic value of highway transport and have made use of it as a part of their own transportation systems. Others have advocated its development because they know that it is necessary to the success of their business that facilities should be later carried by railways. Others have been concerned regarding the development of highway transport from the standpoint of destructive competition with railroad transportation and have endeavored to curtail its development through legislative action. Others, and it is hoped that there are only a few of this class, have considered the subject from such a narrow viewpoint that they have advocated a curtailment of highway improvement.

The Advantages of Co-ordination.—Do we need to go further to realize the vital character of the problem we have under discussion, and the necessity of developing in the minds of the people, our representatives in legislative halls and the operators of the four great systems of transportation that only through co-ordination of all and the enactment of legislation which will permit the efficient development of each agency will the public welfare best be served.

It may appear audacious to bluntly announce that highway transport is an aid to the railroads, especially in view of statements frequently appearing, such as that of one railroad president, who charged a deficit of $4,856,000 to motor vehicle competition. Bald conclusions of this character appearing in the public press bring to the mind of the reader the much maligned motor truck tearing up the public highways. The public does not analyze the true meaning of the loss in revenue. It does not appreciate the large percentage of reduction of railroad receipts due to the operation of the family motor car. It does not know that some railroads are experiencing a reduction in gross revenue, but would not suffer a loss in net profits provided that they efficiently used their facilities for the handling of those phases of transportation for which they are preeminently adapted to handle profitably.

The average citizen has lost sight of the usual consequences which follow the development of a new mechanical invention of benefit to mankind and the use of which contributes to national progress. Many railroad officials appear to have forgotten what happened to canal and river traffic and profitable commercial highway transport in the days when stages constittued the only common carrier for overland transportation. The disastrous effect on the balance sheets of canal, river and stage companies of the laying of hundreds of miles of rails wherever there was an evident field for bulk or mass transportation is a chapter in the story of railroading known to all.

Railways Always Will Be Vital Part of Transportation System.—Railroads are not going to cease to function because of the development of highway transport. The railways are, and always will be, a vital part of our transportation system. They, however, have an economic field which has clearly been defined by Professor Henry E. Riggs of the University of Michigan when he said at a convention of the National Highway Traffic Association that "Railway transportation for long distance business, and for all carload business where there is direct track connection to the factory or warehouse of the shipper is, and always will be, more economical than any form of highway traffic." The writer is an optimist and, therefore, believes that the American railroad official will see the light shining

from the beacons of publicity and dissemination of knowledge and will soon administer his system of transportation with full recognition of the true value of highway transport to the railroads and the part which it will play in national development.

The railroads can render immediate valuable service to the public and to themselves by helping to direct the development of highway transport as feeders to rail lines and as extensions of rail service. A correct and immediate solution of the inter-relationship between these two links of our national distribution system is very desirable in the interests of public welfare.

How Railways Can Use Highway Transport.—What are the opportunities for the railroad to function as an operator or user of highway transport?

First: The transportation of freight by motor trucks from one railway terminal to another in the same or nearby city. The advantages of the utilization of highway transport, as compared with the tedious method of rail transportation by "trap" or "transfer" cars over congested tracks have been appreciated by a few railroad officials. It has been established in some cities, notable examples being found in Cincinnati and St. Louis.

Second: The organized delivery with motor trucks of carload freight from public team tracks in large terminal areas. With such a system in effect, it has been stated that the present freight car equipment of the railroads would be sufficient to meet all transportation needs for several years to come.

Third: Extension of transportation service through the medium of motor truck and motor bus routes. There are several methods of development practicable in this field. Urban and interurban electric railway lines may logically expand their passenger transportation facilities through the establishment of tributary motor bus routes. During 1922, 60 electric lines throughout the United States used motor buses to supplement their rail service. Steam railroads may enter this field through the development of intercity and rural motor express lines to carry both commodities and passengers. One of the most notable examples is afforded by the highway transport services of the Great North of Scotland Railway Company, which established its first motor truck service in 1904. In 1921 this railway company was operating five passenger routes and seven intercity motor truck routes. Railroads having stations in scenic areas may well give consideration to another development by the Great North of Scotland Railway Company, which operates from Aberdeen a motor bus line for tourist traffic.

Fourth: The collection and delivery of freight in municipalities and adjoining areas, which is similar to the methods unversally employed in large cities for handling express shipments. This phase of highway transport would be a development of what is commonly known as the store door delivery plan. The ruling of the Interstate Commerce Commission in the case of the Baltimore development along this line means that it is impracticable for interstate railroads at present to use their own trucks in this manner except on such a large scale that the charge of discrimination in services rendered could not be brought against them. It is possible, however, to arrange with a large trucking organization to render this service. A development in Michigan is the plan of the Detroit United Railway to establish a pick-up and delivery system with motor trucks especially equipped to carry box containers, one or more containers being used for the freight of one shipper. In England, we find railroads functioning as operators of highway transport in this field. One of the most notable examples is the case of the London and Northwestern Railroad's comprehensive system of freight delivery by motor trucks in areas with headquarters at London, Birmingham, Manchester, Liverpool and Leeds. This railroad established its highway transport service in 1905. In 1920, it was operating over 350 motor vehicles.

Motor Trucks Instead of Branch Lines.—W. H. Lyford, vice-president of the Chicago & Eastern Illinois Ry. Co., believes that another field for the profitable use of the motor truck is the transportation of freight between communities which are served by branch lines of railway on which the traffic is too light to pay the expenses of any kind of railway transportation. He further says that no more such branch lines ought to be constructed if the highway transport operator

will take over this field and occupy it intelligently and efficiently, and that money losing branch lines along which transportation by motor truck over existing highways could be furnished at less expense should be abandoned.

To cut down operating costs on branch lines, 40 steam railroads are now using flanged wheel motor buses. Another development may be the reconstruction of the railroad roadbed as a private highway for the use of the railway company's trucks and trailers, or its operation as a toll-road, which, if properly constructed without grade crossings for four lanes of traffic, could accommodate slow moving trucks and trailers and high speed motor buses.

Elisha Lee, vice-president of the Pennsylvania Railroad, goes a step further when he states that "The railroads still do a great deal of purely retail business. Some of it perhaps pays its way, but much of it unquestionably entails a loss. In the immediate vicinity of all our highly developed commercial and industrial communtiies, an immense amount of such traffic oriignates. A large portion of it moves only a few miles, but in its handling we are obliged to employ the most costly and over-worked facilities which the railways own, namely, the yards and terminals in the great centers of industry and population. Here is a real opportunity for the motor truck to demonstrate its utility upon a true economic basis. The reason why less than carload traffic, especially on the shorter hauls, is becoming a growing burden upon the railroads is that we are obliged to use in it terminal facilities and rolling stock which are too expensive for the purpose and which of necessity must be primarily planned and adapted to the handling of bulk traffic, mostly moving over the longer hauls. Therefore, I believe it to be at least probable that in many instances the short haul less-than-carload freight traffic could be turned over bodily to motor trucks with resulting advantage to the railroads and the patrons."

Interrelationship Between Railway and Highway Transport.—The views of state officials on certain phases of the interrelationship between railway and highway transport are indicated by the following excerpts from the 1922 report of the committee on motor transportation to the National Association of Railway and Utilities Commissions:

"Auto truck transportation meets a public demand in the rapid transit of less-than-carload shipments, including the door-to-door delivery element which railroads have thus far failed to furnish. Railroad companies have exhibited a degree of indifference or slowness bordering on stupidity in recognizing and meeting demands of the public for quicker and more convenient movement of less-than-carload freight.

"It is evident if rail carriers hope to retain their short haul freight traffic, it will be necessary for them to make radical changes, both in service and equipment. Trucks are rendering an astonishing service between shopping centers and outlying trading points. Country merchants prefer direct truck service to the railroads, even where the cost of the service is equal, for the reason that the trucks call at the wholesale house, receive the commodities desired and unload them at the store doors. This enables the country merchants to conduct business with a smaller stock of goods, for the reason that new supplies can be obtained conveniently and on short notice through truck service.

"Another respect in which truck service is preferable, is in the movement of household goods from one town or city to another. The principal expense in shipping by rail consists in crating the household goods and preparing them for shipment. In addition to the cost of crating, is that of cartage from the house to the depot and from the depot to the house. Furthermore, these additional handlings increase the loss and damage by breakage. It is difficult of course for rail carriers to meet this sort of competition, and thus far they have apparently made no effort to do so."

The cost of crating for railway shipment is well illustrated in the case of the transfer of the Davis Library of Highway Engineering and Highway Transport from Columbia University in New York City to the University of Michigan in Ann Arbor. The contract price for the crating of the library, the contents of which filled one freight car, was $1,000, while if the library had been transferred by motor truck, it would only have been necessary to box books and

periodicals, the cost of which was $120. Another illustration is the case of the Remington Typewriter Company, which transports from its factory in Connecticut all of its typewriters consigned to New York City by motor trucks equipped with special compartment bodies. The saving in cost of packing is $1.00 for each machine, or $300 for each truck shipment.

In closing, allow me to transmit to you the following pertinent message from our late president, Warren G. Harding: "The transport facilities of the whole world, whether by rail or by water, or whether represented by the great network of public highways, have been confronted with a most difficult situation for a number of years. It is one which demands the very best and wisest treatment from the standpoint of both the technical and economic and financial authorities. The whole program of transportation—in all its phases it must be regarded as that of a single problem—is among the most pressing and difficult that the entire world is facing today."

Relation of Motor Transport to the Railways

A comprehensive plan for linking organized motor transport with the railroads in the development of a balanced national system of transportation is outlined in the report of the Committee on the Relation of Highways and Motor Transport to Other Transportation Agencies submitted Nov. 18 to Julius H. Barnes, President of the Chamber of Commerce of the United States.

Sweeping changes in prevailing methods of handling and distributing freight are proposed. Store-door collection and delivery to relieve congestion within the crowded terminal areas of large cities, the use of organized and responsible motor transport to relieve the railroads of various forms of uneconomical service, including the unprofitable short haul, the wider use of self-propelled railway cars and the extension of passenger bus service to supplement existing facilities are recommended.

To pave the way for these changes in the public interest the committee suggests the regulation of common carrier operations of motor vehicles by the federal and state commissions which have supervision of rail and water carriers, and the systematic development of highways in response to general traffic needs.

The committee, of which Alfred H. Swayne, Vice President of the General Motors Corporation, is chairman, is one of five designated by the president of the national chamber to study different phases of the transportation problem and lay the groundwork for a national policy to be discussed at a general transportation conference to be announced later. Its recommendations represent the unanimous view of all the important interests directly concerned in or affected by transportation. Its personnel includes railway traffic officials, officers of farm and labor organizations, representatives of the motor industry, motor haulage companies, water carriers and the shipping public.

The members of the committee, besides the chairman, are: W. J. L. Banham, General Traffic Manager, Otis Elevator Co., New York; L. W. Childress, President, Columbia Terminals Co., St. Louis; D. C. Fenner, Engineer and Manager, Public Works Department, Mack Trucks, Inc., New York; Gerrit Fort, Vice-President, Boston & Maine R. R. Co., Boston; Philip H. Gadsden, Vice-President, United Gas Improvement Co., Philadelphia; W. H. Lyford, Vice-President and General Counsel, Chicago & Eastern Illinois Ry. Co., Chicago; Ralph H. Matthiessen, President, Motor Haulage Co., New York; John D. Miller, President, National Milk Producers' Federation, New York; H. H. Raymond, President, Clyde Steamship Co., New York; Arthur T. Waterfall, Vice-President, Dodge Brothers, Detroit; Henry J. Waters, Editor, Weekly Kansas City Star, Kansas City; Robert C. Wright, General Traffic Manager, Pennsylvania R. R. System, Philadelphia.

Conclusions of Committee.—The committee was organized early in the present year to study the part the motor vehicle might advantageously play in the building up of an adequate system of transportation and the service that might be rendered by organized motor transport in moving the constantly growing stream of traffic. As a result of its study the committee announces the following conclusions:

1. "The best interests of the public and the rail, water and motor carriers lie in cooperation between the various agencies of transportation rather than in wasteful competition.

2. "The greatest opportunity for cooperation is at the points where the capacity of the railroads is most limited and expansion is most difficult and costly; that is, in the terminal areas of our great cities.

3. "Store-door delivery by motor truck, which would relieve congestion in these terminal areas and greatly increase the capacity of the freight stations, is undoubtedly the greatest contribution which can be made to the solution of the terminal problem.

4. "Organized motor transport can also relieve the railroads of various forms of uneconomical service, such as trapcar service, switching between local stations and short-haul shipments within the terminal area. This will reduce yard congestion and release many cars for more profitable line haul.

5. "To secure the fullest benefit from this organized motor transport, ther development of modern technical equipment, such as demountable bodies, trailers and semi-trailers, containers and container cars, and mechanical handling appliances.

6. "Outside of the terminal areas there are distance zones, varying in different localities and for different commodities, in which one type of carrier, the motor for short haul and the railway (or waterway) for long haul, is clearly more economical than the other, and intermediate zones in which competition is inevitable. The motor vehicle also has a wide field where there is no other agency available. Motor trucks and buses should be used to supplement the facilities of existing common carriers.

7. "It is to the public interest, as well as to the interest of the respective carriers, that the economic limitations of each type of carrier be recognized, that the railroads be permitted to discontinue unprofitable service to which the motor is better suited, and that the motor abandon its efforts to handle general traffic over excessive distances. However, because of the public interest which affects the operation of railroads, they have performed and must continue to perform some service which is unprofitable, chiefly in territory where the performance of highway transportation would also be unprofitable. If the railroads are to be deprived of a substantial share of their more remunerative traffic through unfair and, to the trader, uneconomical methods, the traffic remaining to the railroads must take on an added burden in the form of higher rates or impaired service. In all cases where the railroad can handle traffic with greater or equal efficiency, all factors being considered, the public interest requires that it be allowed to do so. Unprofitable steam railroad service can in some cases be successfully replaced by the use of self-propelled railroad motor cars.

8. "To insure to the public continuity and reliability of service, sound financial organization of motor transport is necessary, as well as public regulation of common-carrier motor service.

9. "Passenger bus transport should be so regulated as to secure the best service to the public, certificates of public convenience and necessity as already required in many states being a useful means of insuring reliable and continuous service. Rail lines can often advantageously extend or supplement their service by bus lines, and in states where this is now prohibited such restrictions should be abolished.

10. "Regulation of traffic and of size, weight and speed of motor vehicles by states and municipalities having control should be made more uniform within states and as between states. Regulation of common-carrier operations of motor vehicles, including rate regulation, should be handled by the federal or state authorities, under the commissions which now control the operations of rail and water carriers.

11. "Trunk highways in any area should be able to carry the normal vehicular traffic of that area, and, if the traffic economically justifies the use of especially heavy trucks, highways with stronger subbases must be provided. This constitutes a problem requiring particular attention in the design of highway systems and in the regulation of traffic. In other respects present types of highways, present routes connecting principal centers of population and production; and the present trend in size, weight and speed restrictions of vehicles using highways show a rational sys-

tem of highway development that should be continued.

12. "Investigations now under way by the U. S. Bureau of Public Roads, state highway departments and other agencies to determine more fully the economic role of the motor vehicle should be continued."

How the Motor Truck Can Relieve Terminal Situation.—"The congestion of transportation", the committee continues in its report, "today centers around the terminals of our great cities, and it is at these terminals that the railroads find the greatest difficulty in keeping pace with the public need. With hardly an exception the main tracks of our railroads have sufficient capacity for the movement of more freight than can be offered to them. With hardly an exception the railroads are constantly faced with a demand for more and better terminal facilities in the face of prohibitive real-estate values and other stupendous obstacles to expansion. Here lies the greatest opportunity for the motor truck. By the use of motor transport the facilities of the terminals can be so expanded as greatly to increase their capacity.

"The general demand for more and better rail transportation is insistent, and the railroads are confronted by a serious dilemma. They must either add to their present terminal facilities or find a way to pass more freight through them. Enlargement or multiplication of terminal stations and team tracks in important terminal areas is practically impossible because of the prohibitive cost, objection of municipalities to the expansion of railroad holdings in congested areas, and furthermore the additional traffic congestion that would result from greater centralization of cartage operations in such areas.

"There are three principal directions in which the motor truck can serve to relieve the terminal situation:

"1. By organized cartage instead of the present go-as-you-please methods of receipt and delivery at the rail terminal; further than this, by store-door delivery, which is real completed transportation.

"2. By substitution of motor service for a part of the rail service.

"3. By complete elimination of certain rail service. This would cover intraterminal movement, such as movement between industries or different plants of the same industry within the terminal area, which would then be handled by motor truck."

Subsequent reports to be made to President Barnes by the other four committees of the transportation conference will deal with the development of waterways and waterway traffic, government relations to transportation, railroad consolidation, and the readjustment of relative freight rates. A joint subcommittee will present a report dealing with the much discussed question of taxation of motor and other carriers. Taken together the five reports are intended to present a picture of the transportation situation and to outline a plan of development from the national viewpoint.

Portland Cement Production in October

Production of portland cement in October was the largest for any month this year and incidentally broke all records for a single month. Report of the U. S. Geological Survey just issued places the total production for the month at 13,350,000 bbl. compared with 13,100,000 in September and less than 12,300,000 a year ago. For the ten months ending October 31, over 114,000,000 bbl. were produced, exceeding last year's record output for the same period by 20,000,000 bbl. or 22 per cent.

Shipments from the mills in October were 14,285,000 bbl., an increase of about 11 per cent over October, 1922. Shipments for the ten months were close to 119,000,000 bbl. or more than was shipped during the entire banner year 1922.

Stocks of cement in manufacturers' hands at the end of October were about 4,600,000 bbl. or 450,000 bbl. more than a year ago. Consideration of the fact that stocks of cement at the beginning of the year were very much lower than at the beginning of 1922, and the ten months' shipments have been 17,000,000 bbl. greater than last year, serves to indicate how successfully the industry has coped with the increased demand. The greatly increased efficiency of the transportation systems has helped materially in making this record possible and recent increases in productive capacity have given the industry a substantially greater output.

The Present Situation in Electric Railway Industry

Extracts From an Address Presented Oct. 30 at Annual Convention of Investment Bankers' Association of America

By JAMES W. WELSH
Secretary, American Electric Ry. Association

The U. S. Bureau of the Census is just completing its regular five-year census of the electric railway industry. So far the complete financial figures for the country are not available but the traffic figures are:

In 1922 out of more than 15 billion passengers, including transfers, over 12½ billion pay passengers were carried by the electric railway companies in the United States, an increase of 1¼ billion, or 12 per cent over the previous census of 1917. This is an increase of aproximately 2.5 per cent per year, while population has increased less than 1 per cent.

We find there were 117 revenue passengers carried per inhabitant the country over in 1922 as compared with 109 in 1917 and 100 in 1912.

Fares and Operating Revenues.—Now let us consider the matter of fares, for upon these two factors, fares and traffic, hang the revenues of the electric railway. In 1917 the average fare per passenger was 5.1 ct., today it is 7.3 ct., and in 1921 it reached 7.5 ct. A trolley ride and a fixed fare no longer are synonomous and the public has come to realize that fares vary in accordance with the cost of service in different cities throughout the country.

Operating revenues of electric railway companies, according to association estimates, have increased 47 per cent over 1917 and now are close to a billion dollars annually. The operating ratio which rose from 65 per cent in 1917 to 80 per cent in 1920 for a group of 225 companies fell to 73 per cent in 1922. The net income is approximately 2.5 times the 1917 figures.

Why Less Tracking Is in Service.—The abandonment of electric railway trackage in certain parts of the country has been cited as evidence of the decadence of this mode of transportation and its replacement by another. The government census figures show a track mileage of 43,934 in 1922 as against 44,808 in 1917, or a net loss of 874 miles, amounting to 2 per cent. It is not to be understood, however, that no new extensions have been made. Detail figures on file with our association show that new track developments to the amount of 1,450 miles have been made during the five years while abandonments aggregating 3,320 miles have occurred, the net loss being as above.

One reason for this was that the country was approaching the "saturation point" with respect to electric railways. Practically every community that offered the slighest possibility of successful operation had an electric railway system. And many that did not offer any possibility nevertheless had them anyway, financed usually by real estate speculators who expected to get their money back through increased land values rather than from the successful operation of the railway, though as to this they were not without hope.

Another reason for the decline in construction was the rise in prices of all materials with the opening of the world war. This abandoned trackage represents construction in unprofitable districts where the traffic could not bear the cost of service. Every industry constantly experiences such changes, and the sooner it recognizes it, the healthier it is for it.

In many of these places electric railways have installed a bus service rather than have the district without transportation service. A total of about 2,000 miles of bus route is now being operated by railway companies.

Our records show that a total of over 13,000 new street cars have been purchased and put in service during this period out of 80,000 in regular operation. These include both replacements and additions to service, but they always make friends for the railway. In 1921 there was expended $150,000,000 for improvements and betterments and for the current year it is estimated $250,000,000 in new capital is needed.

The Motor Bus Cannot Undersell Trolley Service.—Those who fear that the motor bus will replace the electric railway might do well to consider the economic and legal principles involved. It has been definitely proved wherever a complete transportation system serving a whole community has been tried by motor bus that the cost is greater than by electric rail-

way, except in instances where the service is infrequent and the density of traffic light.

Examples of profitable operation of the bus at lower fares are frequently quoted as evidences of its ability to undersell the trolley. The fallacy of this contention lies in comparing a rate of fare on one bus route or a group of favorable routes with that of a whole trolley system serving all parts of the community. It may not be generally understood that the earning capacity of various routes in a community vary through the widest possible range and that where a transportation company provides a universal service many long-haul and poorly patronized routes are carried at the expense of the short riders in the densely populated districts, all for the great good of the greatest number.

The principle of co-ordinating all agencies of transportation serving the needs of each community rather than to permit a ruinous and destructive competition to develop has been promulgated by the American Electric Railway Association and is generally recognized as sound economic doctrine and in accordance with the principles of public utility regulation and control.

Bus Regulation in Various States.—What is the attitude of the regulating commissions with respect to responsibility for furnishing transportation services?

Twenty-five states and the District of Columbia have enacted legislation requiring motor vehicle common carriers to obtain a certificate of public convenience and necessity from the state commission as a prerequisite to the establishment of any kind of service.

A distinct trend from a policy of encouraging motor bus lines wherever possible to one of affording adequate protection to existing carriers can be traced in the decisions of 11 commissions on petitions for certificates.

In only two states, Illinois and Nebraska, where the commission has authority to grant certificates of public convenience and necessity, have they shown a tendency to encourage development of bus lines at the expense of the railways, and in the state of Illinois at least the courts have stepped in and reversed the decision of the commission.

In many states the commissions have as complete jurisdiction over bus operations as they have over other public utilities, including electric railways. For instance, in 19 states the commission has authority to investigate and fix the rates of fare charged by bus lines; in 14 states it prescribes routes, and in 16 states it prescribes schedules for bus lines. Seventeen of the state commissions have issued general orders promulgating rules and regulations for the operation of buses. Thirty-six states have imposed a gasoline tax. There are, in fact, only six states in the union which have taken no official action whatever with regard to the buses.

The Industry Building Up Good Relations With Public.—Another fear that at times impairs the credit of the industry is the threat of political oppression. Probably the most effective weapon against the antagonist is the building up of good public relations. Telling the industry's story to the public, however, has become a national watch-word. This is not a spasmodic campaign, but is a continuing activity in keeping the public advised of its responsibility in maintaining its transportation service. Coupled with this has been the introduction of all known means of economical operation. This included one-man cars and for the industry there are now 10,000 in operation as compared with less than 1,000 in 1917. Organized safety methods are resulting in a material reduction in the cost of accidents, which for the industry have fallen from 3.24 per cent of gross receipts in 1917 to 2.68 per cent in 1922.

The use of automatic and remotely controlled sub-station equipment as a factor in reducing power costs has received wide application. This, together with the use of power saving devices and a more intelligent use of electricity, are resulting in material reduction in the total cost of power. The use of electric and metal composition welding processes has effected material savings in the maintenance and repair departments.

Improved relations with labor have been effected in many places with a corresponding increase in efficiency and elimination of loss through strikes. These are but a few of the economies typical of what wide-awake and progressive companies are doing and which are winning for them success beyond their fondest hopes.

Motor Bus Operation by Electric Railways

Extracts From Committee Report Presented at Last Annual Convention of American Electric Railway Association

We think it is generally conceded that there is a place in the present transportation fabric where the motor bus can be used to advantage. Public authorities are gradually bringing order out of the chaotic condition which the jitney introduced into the transportation field seven or eight years ago. We have watched the struggle throughout the country which the electric railways have made under the burden of this parasitical competition, often wondering how long it would take for the public to realize that it was nursing a destructive force, and knowing at the same time that such realization would eventually come and with it regulation in some form or another.

Now that the motor bus is accepted by many communities as having its proper place as an auxiliary to existing transportation facilities, the electric railway companies are becoming increasingly interested in its use in meeting full requirements for transportation in the territory which they serve.

Quite naturally the manager of an electric railway contemplating the operation of motor buses is anxious to make his estimates with as little guesswork as possible, and your Committee feels that in carrying out its instructions it can be of the most service to the electric railway industry by having its report consist of historical data gathered from member companies that have had some experience in bus operation. Such experience has, however, been comparatively short and none of them wish to go on record as being confident that they have solved the various problems involved.

Experience in dictating changes in methods and equipment so that it is very likely some of the information contained in this report may not be strictly up to date, as the report was completed prior to July 1, 1923.

A questionnaire was sent to each member company operating buses and the data collected in this manner has been classified according to the different elements entering into bus operation.

Class of Service Operated.—The committee obtained information as to the class of service operated from 17 street railway companies which are members of the Association. This is shown in Table I.

Table I

Company	Class of service: Supplementary	Class of service: Feeder	Class of service: Independent	No. of buses operated: Base schedule	No. of buses operated: Peak schedule	Av. No. of miles per day per bus operated
A	.....	Yes	.....	2	3	100
B	Yes	Yes	.....	1	1	153
C	Yes	Yes	.....	21	27	81
D	.....	Yes	.....	6	7	148
E	.....	.....	Yes	1	1	185
F	.....	Yes	.....	5	8	70
H	.....	Yes	Yes	16	21	120
I	Yes	Yes	.....	18	8	161
K	Yes	Yes	Yes	7	10	151
L	.....	Yes	.....	2	3	74
M	.....	.....	Yes	4	7	145
N	.....	.....	Yes	5	*7	127
O	.....	.....	Yes	6	7	96
P	Yes	Yes	Yes	66	70	166
Q	Yes	.....	.....	6	10	216
R	.....	.....	Yes	12	16	153
S	Yes	Yes	Yes	9	9	.....

*Nine more cars to be added in 1923.

Seven of the above companies operate exclusively on city routes. Four companies operate exclusively in suburban service; two exclusively in interurban service, two in city and suburban service, one in city and interurban service and one in city, suburban and interurban service.

We find that street railway companies operating bus service are quite closely following the principles stated in the report of the Committee on Trackless Transportation to the American Association in 1922. If a street railway company adopts the policy of providing for all of the transportation needs in the territory served, the possibilities of the bus as an aid to the carrying out of such policy cannot be overlooked.

As to the matter of substituting bus for rail service, this is wholly a problem of economics. In the case of a low earning line faced with heavy rehabilitation or paving charges, the bus provides a means of continuing service with an expenditure for equipment much below the cost of plant renewals or paving.

Proper Equipment Necessary.—If

we are going to sell to the public the idea that street railway companies, as the established transportation agency in the community, should be given the opportunity to furnish the entire transportation service, the importance of having the proper equipment to provide the greatest amount of safety, comfort and convenience cannot be too strongly emphasized and it is pleasing to note that street railway companies are discarding the truck chassis and adopting the improved types as rapidly as the builders are developing them.

In the further development of the chassis, simplicity and accessibility should be the chief aim of automotive engineers. It should be borne in mind that ordinary running repairs are made without removing the body and, therefore, easy removal and replacement of parts from underneath the chassis should be made possible.

It is very desirable that time out of service be the minimum. A unit repair system will most adequately meet this requirement. To facilitate this, attention should be given to standardization.

Consideration must also be given to the peculiar requirements of a vehicle operated in passenger service such as low center of gravity, clutch and gear designs for frequent stopping and starting, adequate and economical power, and spring suspension to give maximum riding comfort under varying load conditions.

This report will not touch upon development as we believe that each company will work this out according to its own requirements. In general, there seems to be no reason why the electric car body designs cannot be used as a base from which to develop a body which will give public satisfaction from the standpoint of safety, comfort and convenience. There will, of course, always be cases which will require specific treatment based on the particular transportation problem to be solved.

Where buses are operated as feeders or in conjunction with the railway service in any manner, schedules must be so laid out and maintained as to correlate the service from both facilities. This result can be obtained with the best economy if the same supervisory organization is responsible for both.

However, where a route is operated independently of the street railway service, it may be found desirable to supervise it with a separate organization.

Overhead and Maintenance.—Most of the street railway companies operating buses are doing so on such a small scale as not to warrant the increase in overhead and maintenance costs necessary if the work were entirely divorced from the electric car work. We believe, however, that this practice ceases to yield maximum efficiency and economy the moment the number of units becomes large enough to keep a separate corps of mechanics, inspectors and cleaners busy during a full working day. Bus chassis maintenance requires an entirely different line of training than that of electric car maintenance and if an attempt is made to spread the supervision and maintenance over both types of equipment, the maintenance of both will be unsatisfactory.

Owing to the wide diversity of local conditions, it is quite impossible for a report of this kind to suggest a standard maintenance organization, but it is believed that as soon as the volume of work warrants, better efficiency and economy can be obtained by completely divorcing the chassis maintenance from the electric car work.

The body maintenance presents an entirely different situation. Bus bodies are now very closely following the type of construction used in electric car bodies and this work can be more efficiently and economically done by augmenting the regular body maintenance force sufficiently to take care of the additional equipment.

Several of the companies which have gone quite extensively into bus operation have either laid plans for or constructed garage facilities separate from those of the railway shop.

Life of Bus Equipment.—None of the companies, by reason of short experience, is in a position to give definite information relative to the life of bus equipment. All of the depreciation is set up on a tentative basis with the idea of revising it, after experience, to the basis of actual conditions as nearly as possible. So long as depreciation is recognized as a part of the cost of operation, it will make small difference under present circumstances whether it is figured on a straight line or mileage basis.

As the life of tires is relatively short, it would seem that the cost of the original tires on the bus should

not be considered a part of the amount to be depreciated. Theoretically the amount reserved out of revenues during the period a bus is operated should equal the original cost of the bus (including the tires) less its salvage or turn-in value. Practically, as in all cases like this, where the experience is limited and the art is in a comparatively early stage of evolution, the amounts currently charged against the revenues and reserved may be considerably at variance with the actually sustained depreciation; but more extended experience will tend to improve the methods of calculating these charges.

In a new art, such as this, consideration must be given to obsolescence and inadequacy, as well as wear and tear, in calculating depreciation charges.

Physical depreciation, or the wear and tear of the bus, depends substantially on the following factors:

(a) The design of the bus.
(b) The quality of workmanship and material used.
(c) Character of maintenance.
(d) Efficiency of the driver.
(e) The grade and proper use of fuel and lubricating oils.
(f) The loads carried.
(g) Rate of speed.
(h) Character of service performed.
(i) Road conditions.

Because of these variable factors, it is difficult to suggest a standard practice for charging depreciation occasioned by wear and tear.

The factor of obsolescence, an element of depreciation over and above that occasioned by wear and tear, should be a matter of consideration, especially where there is likelihood of an appreciable advance in an art. At best, this is always a problematical element and with respect to the bus at this stage of its evolution, at least, operators must apply indefinite theories in their calculations if they attempt to estimate it. Assuming a given bus is permanently discarded because a better developed bus has been placed in the market, it is evident that part of the still serviceable bus is lost with consequent charge against the income over and above the charges currently made thereto and reserved for the depreciation attributable to wear and tear. Theoretically, this added cost should be currently reserved out of revenues as well as the reservations reflecting the depreciation occasioned by wear and tear.

There enters into the study of this subject, however, the practical consideration that many buses, if not all, which might be replaced in regular service by better developed units, could be used in extra service, as spares and in regular service on lines of smaller traffic demand; often the chassis and other parts of discarded buses lend themselves to further utility.

The factor of inadequacy, which is also an element of depreciation over and above that occasioned by wear and tear, is a burden which operates on the income in precisely the same way as obsolescence and is as difficult to measure. The factor of inadequacy in depreciation is substantially occasioned by the traffic demands. For example, a bus with a carrying capacity of twelve might take care of all or its share of the traffic today and later, because of increased patronage, might have to be replaced with a bus with a carrying capacity of twenty-five.

Assuming that the replaced bus, or its parts, could not be further utilized the charge against income over and above the reservations made out of revenues for depreciation occasioned by wear and tear, would reflect the factor of inadequacy.

This burden may be kept within bounds or eliminated in at least two ways:

First: Buses found to be inadequate in regular service, may be further utilized or their major parts utilized.

Second: In establishing bus service, the size of the buses necessary to accommodate the varying traffic demand and traffic growth may be reasonably determined if careful consideration is given to the fact that the bus, because of the nature of its construction and the laws against overloading which are in force in many localities, is less elastic in capacity than the trolley car.

Because of these widely variable depreciation factors, each company must study its own situation and from future experience develop such method as will adequately provide for renewals or replacements as they become necessary.

In addition to bus equipment, the depreciation on such facilities as garage buildings and equipment must

be taken into consideration. As these facilities do not vary a great deal from those of the electric railway, it would, undoubtedly, be safe, at least for the present, to assume the same rate of depreciation in both cases.

Attitude of Public.—With one exception, the information received from member companies operating buses indicate an attitude on the part of the public entirely in favor of bus operation by the street railway companies. This indicates, without doubt, that the public is showing a preference for the dependable service furnished by a responsible experienced transportation agency to that furnished by an agency whose interest in transportation ceases when profits disappear.

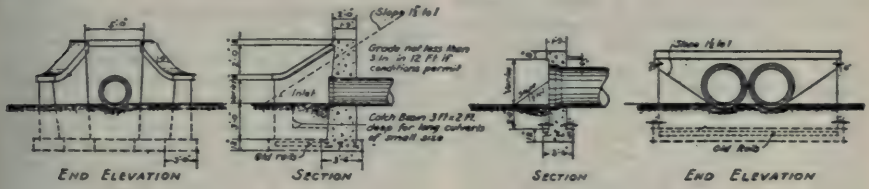
It is also recognized that through supplementing the rail service with buses, additional territory is being served which could never hope to receive service from individual bus operation without a guarantee of immediate profit.

Colombian Railway Expands.—The sum of $2,000,000 will be spent in the near future for general improvements and the gradual extension of the roadbed of the Ferrocarril del Pacifico of Columbia, the entire yearly earnings of the road and a portion of customs receipts being set aside for improvement purposes. In addition, says Consul M. L. Stafford in a report to the U. S. Department of Commerce, a financial commission has recently made tentative arrangements for a foreign loan of $35,000,000, which, if consummated, will permit a large program of improvements and road extension in addition to the yearly sum available.

Headwalls for Pipe Culverts

In connection with its report presented at a recent convention of the American Electric Railway Association, the committee on buildings and structures submitted the accompanying drawing as showing current practice in the design of headwalls for pipe culverts. The maximum diameters for pipes recommended in the report were as follows:

Vitrified pipe	36 in.
Cast iron	84 in.
Reinforced concrete	84 in.
Corrugated iron	84 in.



Footings of End Walls	1-3-6	Concrete
Main Body of Walls	1-3-6	"
Copings	1-2-4	"

Current Electric Railway Practice in Design of Headwalls for Pipe Culverts.

Domestic Business Conditions in October.—Early reports on October business, received by the Bureau of the Census, Department of Commerce, show sustained activity in the production of basic commodities. Steel ingot production, at 3,548,000 tons, compares with 3,316,000 in September and 3,410,000 a year ago. Pig iron production totaled 3,149,000 tons in October, against 3,126,000 in September. Production of cement, Douglas fir lumber, the indicated consumption of tin, and the meltings of sugar increased in October over the preceding month; decrease occurred in the mill consumption of silk, the shipments of locomotives by principal manufacturers, and in unfilled steel orders. The index of general building costs, on a 1913 base at 221, on Nov. 1 compares with 220 for Oct. 1 and 189 for Nov. 1, 1922. Contracts awarded for construction in 27 northeastern states in October increased 26 per cent over a year ago. Sales of mail order houses and 10-cent chains increased seasonally, being well above a year ago.

How to Pick Motor Truck Drivers

Useful Suggestions Given in The Excavating Engineer

By P. L. SNIFFIN

The responsibility placed upon the motor truck driver is too frequently under-estimated. He is solely responsible for the efficient operation and care of a vehicle that represents a large investment. He is the truck owner's representative in the field, and creates an impression among the general public one way or another which is reflected directly to the business. He is legally the truck owner's agent, and for his acts the owner himself is held responsible, as in the case of accidents and violations of traffic ordinances. He may, through diligence, enable his truck to accomplish a large amount of work in a given time, or through an attitude of indifference or laziness cause a high unit hauling cost which will sink deeply into the profits of the business.

The selection of drivers is of even greater importance than the selection of the vehicles themselves. A poor vehicle in the hands of a competent driver is a far better combination than a good vehicle in the hands of a poor driver. Yet, above all, the chief reason for using care in employing drivers lies in the elimination as far as possible of "turnover." It is not only inconvenient but highly expensive to drop one man from the payroll and hire another at frequent intervals. "Breaking in" a new man requires patience that is costly, and obviously too much of this will cause extra wear on the motor vehicles and a higher operating cost.

Primarily, the applicant should be well physically, since a good constitution is necessary for such outdoor work. A nervous, impatient, or high-strung individual is apt to take his temperament out on his truck. Since a sense of responsibility is necessary, most experienced employers give preference to married men.

The more desirable characteristics are caution, dependability and judgment, the qualities which come with age or a more settled position in life. For work of this kind it is generally considered that the dash and vigor of youth are not only unnecessary but quite often are undesirable. It is well to inquire as to the applicant's personal habits and always to look up references and investigate previous employments. If the applicant has had a part in any accidents, these should be investigated as well as the conditions surrounding them.

It is well to consider the following advice from an authority on the subject of driver selection:

"Better results come from training sober, cool-headed, reliable men—possibly teamsters—than from employing mechanical experts of proved ability to take taxicabs around corners on two wheels and to weave through crowded traffic at a breakneck speed. The taste for speed is easier to acquire than to relinquish—and in a motor truck it is not only dangerous but it is an agent of destruction.

"Lack of interest and loyalty is the commonest complaint against truck operators. They fail to keep the truck in good condition, because it makes no difference to them whether it runs or stands in the garage. And a truck that is unduly expensive to operate takes no more from their pockets than one that costs almost nothing in repairs or supplies.

"This is a problem that must be faced and solved by each individual truck owner; some have done it by a system of merits and demerits—reward and punishment for things done or left undone. Others have done it by offering prizes and bonuses to drivers whose cost records reflect intelligent care and attention to the truck itself.

"But whatever plan of remuneration you adopt, and whatever steps you take to insure the driver's interest in the firm, the first essential will be the selection of the driver himself. Don't make the mistake of thinking that any man who can handle a steering wheel is fit to be trusted with your truck investment. Not only may he ruin the truck, but you will be held accountable for any damage to another machine or to persons."

Taxes Paid by Railways.—In 1913 the Class I steam railroads of the country paid $118,386,859 in taxes and $322,300,406 in dividends. In 1921 these railroads paid $275,875,990 in taxes and $298,511,328 in dividends. The taxes exceeded the dividends in 1920 and in 1922.

Method of Repairing and Renewing Ballast Deck Trestles

Extracts From Committee Report Presented Oct. 17 at 33rd Annual Convention of American Railway Bridge and Building Association

When first used on trestles, ballast decks were only about 12 ft. wide and were built with solid stringers; later the width was increased to 14 ft., this being generally done by spiking 3-in. plank 14 ft. long on top of the stringers, allowing the planks to extend 12 in. over the edges of the outside stringers at each side to obtain the additional width. The stringers vary in thickness from 6 in. to 9 in., and the depth from 12 in. to 20 in., depending on the length of span and the kind of traffic handled. In this report the width has been assumed as 15 ft., and the distance from center to center of bents as 15 ft. also.

Adding to Service by Reinforcing Stringers.—The spacing of the stringers has helped in making inspections of this type of trestle. It also effects a great saving when making repairs, as it is often found that by reinforcing the existing stringers a few more years of service can be secured before they have to be renewed entirely. Wherever possible, the stringers should be spaced not less than 7 or 8 in. apart. This will permit the use of 6 in. or 7 in. reinforcing timber between the stringers and will add greatly to the strength of any failing stringer, while saving the expense of tearing up the deck and placing a new stringer in the place of an old or failing once.

Renewing Piles.—There is a considerable variation in the construction of bulkheads and bents on different railroads, some using fir or cedar piles, while others use treated piles, and still others use stone or concrete in both bulkheads and bents.

Where one or more piles must be renewed it is necessary to remove the deck planking to move one or more of the stringers to allow the pile to be driven in its proper place in the bent. A large amount of time can be saved if piles of small dimensions are selected for this repair work. They can be spaced in the bent where the ends of the stringers are joined on the caps by lifting the deck plank on one panel, jacking or wedging the end of the stringer over against the next one, and thus enable the new pile to be lowered between the stringers without removing any stringer entirely.

If the bents are of sufficient height to allow the piles to be driven alongside the caps and then pulled under after being cut, it will eliminate the necessity of removing and replacing the caps. This can be done if the bents are over 10 ft. high. Of course, when the stringer deck is solid it will be necessary to remove enough stringers to allow the new pile to be placed between.

If the bents are too low to permit the piles to be pulled under the caps it will be necessary to remove the caps in order to get the piles in proper position. If traffic is very heavy it is often necessary to cut out a portion of the cap, then drive the new pile and put on a new cap.

When caps are to be renewed over waterways or streets it is often necessary to spike or bolt a timber to the pile bents, low enough to allow the setting of jacks under the stringers, so that they can be raised sufficiently to allow the cutting of the drift bolts with a hack saw or chisel, the removal of the old caps and the insertion of the new ones. If the time between trains is rather short, it is quicker to cut the old cap in short lengths and split it out with bars.

The best way to fasten new caps or piles must be decided on the ground in each instance. In some cases this can be done by simply spiking them well to the piles and stringers, but in most cases it is advisable to use drift bolts again, even if it becomes necessary to remove the ballast over the cap and one of the deck planks. In solid deck stringer trestles it is necessary to use extra long drift bolts to reach through the stringers and caps into the piles.

Renewing Stringers.—When it is necessary to renew or reinforce one or more of the stringers it will not be much of a job to insert an additional timber between the stringers if the extra stringer is cut to reach the centers of one panel only, and the top edge of the end that goes up first is beveled. When several stringers

are to be renewed in one panel it is advisable to remove the deck planks, replacing them after the new stringers are in place. If the deck planking is to be renewed this simply requires the removal of the ballast, the renewing of the planking where necessary and replacing the ballast again.

The experience of practically everyone who has had to do with repairs of this nature demonstrates that the structures are generally in much worse condition than the bridge inspector's report indicates. This no doubt is explained by the difficulty of making a close and thorough inspection unless a bridge gang is in the vicinity while the inspector is making his inspection, on whom he can call for assistance in digging out, so that he can make a close inspection.

Great care must be exercised by bridge gangs in opening up this class of trestle for repairs, because, if allowed to go at it "rough shod," they may damage much good timber in a short time. Many repairs have been called for in untreated timber trestles covered with roofing paper on account of the damage done by section men when removing the surfacing timbers or blocking under the track ties.

How to Renew Ballast Deck Trestles.—When it necessary to renew ballast deck trestles from the ground up the material may well be ordered from the office, but when a new deck is to be placed on old bents it is not safe to do this. In such case it is often found that the length of the stringers will vary as much as 5 in. center to center of caps from one end of the trestle to the other, and it is preferable for the officer directly responsible to take these measurements on the ground. He can there decide as to the length best suited and frequently vary the measurements enough to make the stringers the same length all through the panel, although occasionally he will find a difference of 5 in. or more, and he then has to decide on the lengths to order, as in such cases no two stringers in the panel are the same length.

It is advisable to make a pencil sketch of the trestle, showing all the bents and stringers and the lengths of stringers ordered for each panel. If this sketch is turned over to the foreman who is to do the work he will have no difficulty in selecting the correct length of stringer for each panel. When new caps are to be installed they can be shifted a little to one side in order to help out the variation in the length of spans. This will also have to be decided at the time measurements are being taken for the lengths of stringers. On double trestles a variation of 10 in. has been found in the lengths of 30-ft. panels, in which case there are 11 different lengths of stringers in one panel.

After the requisitions have been placed the material should all come forward at one time, so that it can be handled by a work train and unloaded on the ground at the place where it is to be used. If it is a short trestle or is located near a siding or yard the cars may be placed for unloading by a local freight train. Whenever possible the different lengths should be piled together. If the trestle is an extra long one material should be ordered in sections and come forward complete for each section.

Disposing of Old Ballast.—After all of the material is on the ground ready to start work the first thing to do is to get the old ballast out of the way. As a rule it is cheaper to waste the ballast over and under the trestle than to try to save it and use it over again. Over streets or tracks it may be necessary to load it and haul it away. On short trestles when the ballast is clean it may be economical to haul it to the ends and use it again when the renewal is completed, but it should be done only when the ballast is clean.

As the ballast is removed it is necessary to keep the track up near its surface and safe for trains. This is usually done by placing enough of the outer stringers that are being removed under the track ties and between the ties and the old deck plank. Where the old ties are uneven it will be necessary to shim enough of them to keep the track safe for the passage of trains. After all of the ballast has been removed the old deck plank can be lifted and drift bolts removed from the old stringers. This is generally accomplished by the use of a homemade puller.

If new pile bents are to be driven

throughout the structure they should be located so as to clear all of the old bents as much as possible in order that the new bents can be cut off, capped and braced before they are called on to carry much, if any, of the weight of the traffic. This cannot always be done, as in cases where permanent abutments are already in place. Here the new bents must be placed in practically the same location as the old ones, and it will be necessary to follow the method used in replacing piles described in the first part of this report.

In renewing stringers a locomotive crane is very handy, but as all roads are not equipped with this tool the work frequently has to be done by hand. As soon as enough new stringers are in place and bolted it is advisable to start some men placing and spiking the new deck plank, as this helps to stiffen the new deck considerably. The guard timbers should then be placed, after which the trestle is ready for the new ballast. In placing the ballast only enough should be dumped to permit the removal of the temporary blocking under the track ties, after which the balance can be dumped.

The Maintenance of Track Joints

Paper Presented Sept. 19 at 41st Annual Convention of Roadmasters and Maintenance of Way Association

By R. S. COCHRANE,
Engineering Department, Atchison, Topeka & Santa Fe Ry.

That rail constitutes, next to ties, the largest item of expense in the track structure goes without saying. It is equally true that its life is limited by the deterioration at the joints rather than by wear throughout its length. It is a strange anomaly, after all these years of concentrated effort, of double distilled wisdom, filtered and refiltered through the fine screen of experience, that the charge should be made and admitted within limitations that the joint and not the rail fixes its life.

Rail Failures at Joint.—The joint occupies a fraction over 6 per cent of the length of a 33-ft. rail. It is rather well believed that failures at the joint are in excess of this proportion. On the Santa Fe system where 90 lb. rail is the heaviest and joints are given its standard attention, the percentages of rail failures at the joint for the periods given are as follows:

Year	Total Failures	In Joint	Per Cent
1921	1,853	238	12.8
1922	1,765	107	6.06
1923 (8 months)	1,854	63	3.4

A recent canvass on the Santa Fe showed that our joint ties possessed a life of approximately 70 per cent that of intermediate ties so that here again the joint gathers toll. Interpreted into money and considering only the two ties involved at the joint, this means an untimely loss of $2 per joint or $320 per mile every five years, based on a life of 16 years for intermediate and 11 years for joint ties at 20 cents per year. Bear in mind that these ties are creosote treated after being bored and dapped.

Slot spiking for anchorage accelerates both mechanical wear and decay, the remedy for which may be found in part in rail anchors. Tie spacing —uniform, nonuniform or special, with as many varieties of demands on the joint, all intended to assist and render equal or improved service, is still a problem. For our line I plead guilty of all three methods.

Another problem is the control of expansion. Highly abnormal maintenance with far reaching effect on elements not otherwise effected may result from improper handling. The joint may be made to well play its part in holding expansion.

The Track Bolt.—In looking back it appears that the bolt has been overlooked, its duty considered, as an indispensable aid in joint maintenance. Poor bolts have contributed more to your troubles than poor joints. The deduction at least may be made if rail wear is dependent upon joints, and joints in turn on bolts, then the main dependence of rail wear is on bolts.

Specifications for bolts adopted by the American Railway Engineering Association provided for 75,000 lb. yield point and 100,000 lb. ultimate strength, heat treated and quenched bolts carrying an increase in strength of 100 per cent (which cost 6 per cent additional to produce)—an epochal event since with the heavier and stronger design of joint bars coming

into use, the heat treatment of which soon followed, it marked the point where the maintenance of this so-called weak link in the chain, the joint, in the desired degree of tightness, was for the first time a possibility.

With the knowledge of the benefit reaped from the former changes, the American Railway Engineering Association revised its bolt specification last March, to increase its elastic limit from 75,000 lb. to 85,000 lb. and its proposed ultimate strength from 100,000 lb. to 110,000 lb. for heat treated bolts which makes more certain the possibilities of better joint maintenance that are to be developed.

At the same session there was also adopted a schedule of track wrench lengths proportioned for the strength of the untreated and treated bolts. The provision of a better bolt with nuts thickened in proportion was a real accomplishment and it would seem that the problem was again solved since we still retained the long wrench and a strong back. The change to a better bolt, however, cannot change the natural characteristics of track, evidenced by its flexibility and elasticity so productive of wear throughout.

In general wear is a product of friction through movement superinduced by and proportioned to looseness. Stronger bolts alone will not completely return to either a strong or a weak joint its full measure of strength by arresting looseness or wear, unless maintained continuously and uniformly tight, which condition is not accomplished with hot riveted bolts, positive forms of nut locks or periodic tightening, for it is in the interval between tightness and looseness that the greater damage is done.

The Purpose of Nut Locks.—B. M. Cheney, in an article in the February, 1923, issue of Railway Engineering and Maintenance, summarized in their relative importance the answers made to the query, "What is the purpose of a Nut Lock?" as follows:

"To prevent nuts from turning back.

"To preserve sufficient threads on the bolt to permit future tightening.

"To provide leeway so that nuts can be loosened in hot weather to allow contraction and expansion of the rail.

"To reduce vibration or friction."

It is correctly stated that the ordinary nut lock exerts a maximum pressure of about 3,000 lb., as in all spring members this pressure diminishes with reaction. Reverting to the revised specifications of the A. R. E. A., covering track bolts, it is evident that an adequate bolt of 1 in. diameter should be capable of withstanding an actual applied load of approximately 27,000 lb. If such a load is applied, is it not desirable to retain such a load automatically. It not, why apply it initially?

That we do not stop with this 3,000 lb. pressure, accounts for bolts being stressed or broken in tightening or in tightening plus traffic with the common result that wear in rails, joints, ties and ballast is magnified and deterioration is hastened. In the article referred to, attention is called to the fact that increased strength in bolts, calls for an increased means of preserving tightness, since the stronger bolt makes the ordinary nut lock less capable. It was pointed out that nut reversal for which the nut lock was originally devised is now incidental and the main need is spring pressure proportioned to the intensity of pressure applied on the bolt through wrench or traffic load to prevent initial wear of jointed parts and to compensate for recurring wear due to inadequate track supervision — in other words, to retain in so far as is possible the initial security of track joints. To quote from a footnote in the A. R. E. A. specification of 1915, for nut locks, "That amount and durability of reactionary power under constant pressure is the true test of any spiral nut lock." In March, 1923, the A. R. E. A. revised its specifications covering coiled nut locks, and changed the name to coiled spring washers to include the higher pressures specified for these accessories without their flattening.

There is no doubt that the adoption and use of spring washers conforming to these specifications will not cure all of the joint ills from which we suffer, since we still have ties and ballast as the support for our track, and it will not improve the quality of the rail, but it should effect a distinct saving in the ills attending loose bolts, loose joints, loose ties and battered end rail, and restore that uniformity of surface attending the greater approach to the continuous rail.

Construction News of the Railways

Logging Railroad on Lake Superior Island

The John Schroeder Lumber Co., Ashland, Wis., and Milwaukee, Wis., will build a 12-mile logging railroad on Outer Island in Lake Superior, 40 miles from Ashland. Two miles of tracks have been laid and it is planned to complete the line in the spring.

Santa Fe Shop Extensions at San Bernardino

The Atchison, Topeka & Santa Fe R. R. has appropriated $3,399,843 for shop extensions, new machinery and other equipment at San Bernardino, Cal., where the system maintains the largest terminals on the coast.

Railroad Improvements at Brownsville, Tex.

Grading is under way for an extension of the side tracks and a turntable in the railway yards at Brownsville for the St. Louis, Brownsville and Mexico Ry. A year ago, the company purchased 28 acres of land and at that time announced that shops were to be built and the yards extended on account of the increasing volume in business. The shops were to be built on the unit plan, additional units added as found necessary, and it is understood that this plan will now be followed.

$2,000,000 Railroad Improvements at Jackson, Miss.

Under the agreement with the city authorities the railroad companies entering Jackson, Miss., must begin the work of removing grade crossings in the city by or before Jan. 1, next. The estimated cost of the work of building the elevated tracks and remodeling and enlarging the Union Depot is expected to total close to $2,000,000.

Cotton Belt to Lay Heavier Rails on Texas Division

The Cotton Belt Ry. according to reports will replace the 58-lb. steel rails on the Sherman-Commerce division with new 75-lb. steel, in order to make provisions for larger engines and heavier trains. The work of laying the new rails, it is understood, will be in progress simultaneously on every section division.

New York Central Planning Electrification in New York City

Action looking to the electrification of the railroad lines along the west side of New York City has been taken through a petition of the New York Central R. R. company to the transit commission asking that orders be issued directing the elimination of all grade crossings on the company's tracks from St. John's park north to Spuyten Duyvil creek. Coincidentally the company has petitioned the public service commission to issue orders prescribing the methods through which the change of power is to be accomplished. This step is in keeping with a law enacted by the last Legislature stipulating that no railroad operating within the limits of a city of one million or more shall, on or after Jan. 1, 1926, use any other motive power than electricity within the city limits. The law contemplates the removal of the long opposed steam operation on the tracks just below Riverside drive.

Reading Orders 35,000 Tons of Rails

Steel railroad orders for 35,000 tons have been awarded by the Reading Company for 1924 delivery. The rails will be used for extensions and improvements on the lines of the Philadelphia & Reading Ry.

Pennsylvania R. R. to Spend $350,000 at Sandusky

Improvements to cost $350,000 are to be made at Sandusky, O., by the Pennsylvania R. R. in work including several miles of coal storage tracks.

35-Mile Contract in Oregon Let

John Hampshire, Grants Pass, Ore., has been awarded a contract by the Southern Pacific Ry. for the construction of 35 miles of the Natron cutoff in southern Oregon.

Railroad Improvements at Ogden, Utah

Grading work is under way by the Utah Construction Co., Ogden, for the construction of additions to the freight yards in Ogden. It is reported that about 75 miles of additional trackage will be laid. Bids also have been taken for the construction of a $400,000 union station.

Philadelphia Votes $71,000,000 for Transit and Other Improvements

At the election Nov. 6 the citizens of Philadelphia voted in favor of two municipal loan bills, aggregating $71,000,000, for transit and general public improvements.

$250,000 Railroad Bridge in Mexico

Plans providing for the construction of a railroad bridge by the Southern Pacific de Mexico Ry. Co. at the north end of the Culiacan river in northern Sonora, Mexico, have been accepted by the road and actual construction work on the project will begin soon. The cost of the new bridge is estimated at $250,000.

Florida East Coast R. R. to Spend $10,000,000

The Florida East Coast R. R. plans the expenditure of $10,000,000 on improvements in the immediate future, according to reports. Completion of the Lake Okeechobee extension within the next year or so is a part of the general plans. This will give Miami direct rail connection with the great undeveloped sections of the Everglades. This extension will be from Okeechobee City, near the north shore of Lake Okeechobee, and the present terminus of the Titusville-Okeechobee branch, around the north and east shores of the lake and across the Everglades to Miami. Another of the contemplated improvements is laying of 90-lb. steel rails and rock ballasting of the road the entire length.

Katy to Enlarge Shops at Denison, Tex.

H. D. McCoy, Cleburne, Tex., has been awarded a contract involving $200,000 for the first of several units to be added to the Missouri-Kansas-Texas R. R. car shops at Denison.

B. & O. Spending $45,800,000

The Baltimore & Ohio R. R. improvement program for the current year, exclusive of the purchase of cars, etc., is said to be the most extensive in the history of the road. The work under way or soon to be started will, when completed, cost more than $22,000,000. This is in addition to rolling stock purchases being made this year, consisting of $17,250,174 for freight cars; $5,919,150 for locomotives and $633,075 for passenger cars, a total of $23,802,300.

New Freight Yard at Fort Wayne, Ind.

The New York, Chicago & St. Louis R. R. has acquired 200 acres at Fort Wayne, Ind., to be used for a new classification yard and freight terminal. An engine house and locomotive repair shop will be constructed on the new site.

New Street Railway Belt Line at Portsmouth, O.

The Portsmouth, O., street railway is to build a $300,000 belt line to serve new additions to the city.

Narrow Gage Railroad in California

The Pacific Distributing Corp., San Francisco, Calif., controlling the output of Soda Lake, has awarded a contract to W. B. Burch, Lowe Bldg., San Luis Obispo, Calif., for constructing 8-mile narrow gage railroad from Soda Lake.

Belt Line Railroad Proposed for Tacoma

The Great Northern R. R. is reported to have accepted the proposed plan for a belt line railway system for the Tacoma tideflats industrial section. This acceptance follows that of the Northern Pacific and Milwaukee roads and leaves only the Union Pacific to concur to make the agreement unanimous among the transcontinental roads having terminals at Tacoma.

Burlington to Build $1,000,000 Storehouse at Aurora

The Chicago, Burlington & Quincy R. R. is reported planning to begin construction early next year on a general storehouse, to be built in Aurora at a cost of $1,000,000. The plant, one of the largest and most modern in the country, will be located between the present temporary building and the High street viaduct, occupying much of the space formerly used as switch tracks in the old hill yards before the elevation was completed.

5-Mile Line to Be Built in St. Paul

To serve a new plant the Ford Motor Co. is building near St. Paul the Chicago, Milwaukee & St. Paul Ry. has asked the interstate commerce commission to authorize construction of a new 5-mile line within the city limits of St. Paul.

Santa Fe Improvements at Galveston

Authority has been granted by the Interstate Commerce Commission for the Gulf, Colorado & Santa Fe to acquire by purchase certain property rights and franchises of the Galveston & Western Ry., including a line of railroad situated within the city of Galveston, and to operate such railroad. Prior authority had been granted the Santa Fe to take over the Galveston & Western by an act of the Texas Legislature. It is the Santa Fe's purpose to extend the property in the development of Galveston's Industrial district.

Street Railway to Spend $100,000 at Toledo

The Community Traction Co. will expend $100,000 for double tracking in Sylvania Ave., Toledo.

Illinois Central to Issue $12,000,000 Stock for Improvements

The Illinois Central Railroad has been authorized by the Interstate Commerce Commission to issue $12,022,450 in 6 per cent preferred stock to be sold at par to its stockholders for cash. In addition it will issue a like amount of common stock, which shall be held in the corporation's treasury unless preferred stockholders desire to convert their holdings into common. The funds will be used to continue the improvement and electrification of the road's Chicago Terminal, an investment which will total when the work is completed about $88,000,000.

North Carolina Railroad to Make Improvements

The High Point, Thomasville & Denton R. R., High Point, N. C., has secured a charter amendment increasing capital stock to $1,000,000. It runs from High Point to High Rock. Heavier rails will be purchased and other equipment added.

18-Mile Railroad Job in New Zealand

The Public Works, Tenders Board, Wellington, New Zealand, will receive bids until noon, March 18, 1924, for the construction of 18 miles of railway including bridges, station buildings, earth work, ballasting, etc.

Locomotive Shipments in September

The U. S. Department of Commerce announces September shipments of railroad locomotives from the principal manufacturing plants, based on reports received from the individual establishments.

Table I compares the October, 1923, figures with the previous month and with the corresponding month last year, as well as totals for the year to date, compared with a year ago, in number of locomotives:

Table I

	Oct., 1923	Sept., 1923	Oct., 1922	10 Months' Total Jan. to Oct. 1923	10 Months' Total Jan. to Oct. 1922
Shipments:					
Domestic	295	313	133	2,410	718
Foreign	15	22	12	151	187
Total	310	335	145	2,561	905
Unfilled orders (end of month):					
Domestic	915	1,102	1,420	.....	.....
Foreign	62	76	118	.....	.....
Total	977	1,178	1,538	.....	.....

New Railway Across the Sahara.—France, according to press dispatches, will start work early in the spring on a trans-Saharan railroad. It will take 7 or 8 years to build the line. The route starts at Oran and passes by Adrar and Tessalit to Bourem, and terminates at Ouagadougou, capital of the Upper Volta. The French Line and the Paris-Lyons-Mediterranean, which at present own and operate a line between Oran and Raselma, will give certain assistance in the construction of the line in return for certain concessions, the details of which are not yet published.

Dense Street Car Traffic in Shanghai.—Shanghai, China, claims to have the world's largest number of passengers carried annually per mile of street railway track, 7,000,000. Shanghai's annual total of passengers carried increased from 11,000,000 in 1908 to 126,000,000 in 1922, with practically no increase in track mileage. The number of cars, however increased from 64 to 194.

Explosives Used in September

Explosives sold during September, 1923, for use in the United States amounted to 584,701 kegs of black powder, 4,069,468 lb. of permissible explosives and 17,208,632 pounds of other high explosives, according to manufacturers' reports to the Interior Department through the Bureau of Mines. These figures represent slight decreases from the figures for September last year but the cumulative sales for 1923 to date are larger for all three classes of explosives as compared with the first nine months of 1922.

Sales of black powder during September brought the total sales of this class of explosives in 1923, to 5,321,677 kegs, an increase as compared with previous nine-month periods of 34 per cent over 1922 and 39 per cent over 1921, but 29 per cent below the 1920 record. Of the total sales in 1923 to date, 86 per cent was for coal mining, 2.3 per cent for other mining, 5.1 per cent for railway and other construction work, and 6.6 per cent for all other purposes. The amount used for coal mining represents 236 pounds for every thousand tons of coal produced in the United States since January 1, out of 371 pounds of all kinds of explosives used in coal mines.

The amount of permissibles sold in 1923 to the end of September was 41,838,282 lb. This quantity is 65 per cent above the nine-months sales in 1922, and 57 per cent above those for 1921, and 5 per cent above the corresponding figures for 1920. The 1923 sales were distributed as follows: 94.3 per cent for coal mining, 1.2 per cent for other mining, 0.5 per cent for railway and other construction work, and 4.0 per cent for other purposes.

During the first nine months of the present year, sales of high explosives other than permissibles have amounted to 169,101,310 lb. As compared with the corresponding periods of previous years, this quantity represents an increase of 29 per cent over 1922, 47 per cent over 1921, and less than 1 per cent over 1920. The 1923 sales were for use as follows: 15.3 per cent for coal mining, 39.2 per cent for other mining, 10.9 per cent for railway and other construction work, and 34.6 per cent for miscellaneous purposes.

Statement of the Ownership, Management, Circulation, Etc., Required by the Act of Congress of August 24, 1912,

of RAILWAYS monthly issue of ENGINEERING AND CONTRACTING, published monthly at Chicago, Ill., for October, 1923.

State of Illinois, County of Cook, ss.

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared E. S. Gillette, who, having been duly sworn according to law, deposes and says that he is the Circulation Manager of the publication Engineering and Contracting, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Engineering and Contracting, 221 East 20th Street, Chicago; editor, H. P. Gillette, 221 East 20th Street, Chicago managing editor, H. P. Gillette, 221 East 20th Street, Chicago; business manager, Lewis S. Louer, 221 East 20th Street, Chicago.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.) H. P. Gillette, 221 East 20th Street, Chicago; Lewis S. Louer, 221 East 20th Street, Chicago; R. E. Brown, 904 Longacre Bldg., 42nd St. and Broadway, New York.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

E. S. GILLETTE, Circulation Manager.

Sworn to and subscribed before me this 1st day of October, 1923.

(Seal) KITTIE C. WOULFE, Notary Public.
(My commission expires Feb. 9, 1926.)

Buildings

1109

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.
221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*
LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 904 Longacre Bldg., 42d St. and Broadway
RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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(b) Road Maintenance
(c) Streets
(d) Street cleaning

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(d) Waterways

Buildings—4th Wednesday, $1
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures

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Vol. LX. CHICAGO, ILL., NOVEMBER 28, 1923 No. 5

Two Years of the Landis Award

Two years ago this month there was organized in Chicago "the Citizens' Committee to Enforce the Landis Award." This "award," it will be remembered, embodied the decision of Judge Landis as arbitrator on fair wages and working conditions in the building trades. Judge Landis' selection concluded a strike which had ruined some contractors, had nearly ruined others, had worked hardships on many members of the building trades, and had been a trying and costly affair to all parties concerned, including the "public." Both parties to the dispute believed Judge Landis to be one of the very few men, or perhaps the only man, who could render an acceptable decision.

The Judge, already burdened with work, accepted the task as a duty, and gave it the best of his efforts and abilities. He sought a settlement which should be at once just and practical—not a makeshift which would induce the resumption of work without correcting the fundamental defects which would lead inevitably to renewed conflicts. Such a task requires time, and Judge Landis took what was necessary in spite of expressions of impatience from outside. His decision we believe to have been a model of fairness, and as such it was generally accepted by parties the least directly interested. But inasmuch as the wages which it established for the skilled trades were somewhat lower than had been hoped for by many, and as they varied according to the conditions and requirements of different occupations, it drew the fire of certain unions that had theretofore been peculiarly favored.

After protracted disputes in which the arbitrator again displayed his breadth of view, several of the unions broke away and refused to recognize the award, although in the beginning they had pledged themselves to abide by the decision, whatever it might be. The carpenters' union had not entered the arbitration agreement; and its refusal to accept, although regrettable, involved no dishonor.

Following the award was a period of comparative disorder in which some of the unions sought the complete overthrow of what had been accomplished, some of the contractors appeared to be vaccilating, and there was danger of a complete collapse. It was at this stage that the seriousness of the situation for the entire community resulted in the formation of the citizens' committee. That organization made a straightforward statement of conditions, announced its intentions of bringing to bear all possible pressure to secure adherence to the award, and to treat as outlaws those unions which had broken their arbitration agreement.

A large measure of success has crowned the committee's efforts. Open shop conditions have been maintained in those trades which either refused or repudiated the arbitration; and construction, which had approached a standstill in Chicago in 1921, has continued actively. Upon the contractors lies a large share of the blame for the lack of 100 per cent success. Some of them, admittedly hard put, paid union wages to carpenters and to the outlawed trades: a few months ago three of the largest contractors withdrew from the award presumably because of the adverse effect it had on their work in other cities. These actions have imposed an added burden on the other contractors, who have preserved a genuine observance; but they have not destroyed the award, nor except in minor degree impaired its usefulness.

Unfortunately, Chicago's construction industry was afflicted with worse ills than disagreements on wages and working conditions. It was honeycombed with graft. Combinations of dealers in certain classes of materials practiced downright extortion from which escape by either contractor or owner was practically impossible. An astonishing number of union officials and representatives were corrupt and levied tribute where they could, calling it by such names as "strike insurance" or "advertising." Some of the contractors were not less dishonest.

The Landis Award, while it dealt not directly with all of these evils, had its effect upon them, and with other agencies has given the construction industry a firmness and cleanliness such as it has not known for thirty years. The greatest credit is due to all those contractors, loyal union men and others who, often in the face of personal loss, have stood faithfully by the arbitration. They have brought great good to their industry and to their community.

Structural Steel Sales in October

The U. S. Department of Commerce announces October sales of fabricated structural steel, based on figures received from the principal fabricators of the country. Total sales of 107,797 tons were reported for October by firms, with a capacity of 224,060 tons per month. Shipments of firms reporting this item represented 80 per cent of capacity.

Tonnage booked each month by 177 identical firms, with a capacity of 230,675 tons per month, is shown below, together with the per cent of shop capacity represented by these bookings. For comparative purposes, the figures are also prorated to obtain an estimated total for the United States on a capacity of 250,000 tons per month.

1922	Actual Tonnage Booked	Per Cent of Capacity	Computed Total Bookings
October	133,037	58	145,000
November	112,367	49	122,500
December	138,737	60	150,000
1923			
January	173,294	75	187,500
February	184,887	80	200,000
March	220,400	96	240,000
April	186,117	81	202,500
May	131,875	57	142,500
June	118,117	51	127,500
July	117,563	51	127,500
August	134,431*	59	147,500
September	121,045**	53	132,500
October	107,797***	48	120,000

*Reported by 176 firms with a capacity of 229,475 tons.

**Reported by 173 firms with a capacity of 228,425 tons.

***Reported by 156 firms with a capacity of 224,060 tons.

Tension Tests of Limestone

The U. S. Bureau of Standards has recently completed some tension tests on samples of Indiana limestone. This is a novel form of test for a material of this kind, the work having been undertaken in connection with the design of lifting devices used in hoisting large blocks of stone at the mills, and also when being placed in buildings. The tensile values for the specimens tested ranged betwen 300 and 715 lb. per square inch with an average of 535 lb. per square inch.

Solution of Fink Truss Problem

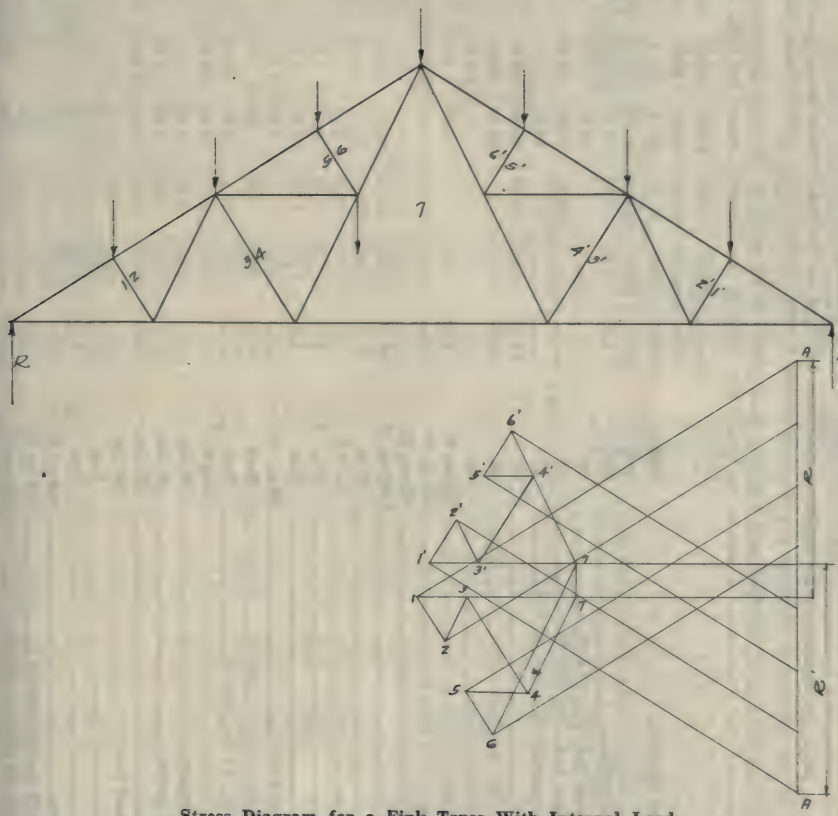
To the Editor: In your issue of Oct. 24 there appears an article by C. R. McAnlis showing a method for obtaining the stresses in a Fink truss with an internal load.

Some 15 years ago I had this probleb to solve while designing trusses which were to carry shafting and motors, and used a solution which is more logical and direct; furthermore, the stresses at any joint can be read in a clockwise manner and the diagram will close. This is not possible with the solution shown in the article to which reference is made.

My solution is as follows:

Lay off the external loads on the line A-A. Letermine the reactions from all loads, by any method. Complete the stress diagram for the unloaded portion and for the loaded portion up to the member 3-4, which will bring us to the members carrying the internal load. Because of a peculiarity of the Kink truss, the members 1-2 and 5-6 can take stress from the external panel loads only, for this reason we know the amount of stress in 5-6, and that it is not affected by the internal load. The point 7 of 6-7 of the unloaded portion is a common point for 6-7 of the loaded portion, therefore we can complete the stress diagram and the closing point of the diagram is at the point 4. The lines 5-4 and 7-4 meeting on the line 3-4 will prove the accuracy of the diagram.

W. Grierson.



Stress Diagram for a Fink Truss With Internal Load.

Retail Prices of Building Materials

Average prices paid Sept. 1, 1928, by contractors for building materials delivered on the job. These prices are secured through the Bureau of the Census and published monthly by the Division of Building and Housing of the Bureau of Standards, United States Department of Commerce.

The report as published by the Division of Building and Housing gives prices at 42 cities, 27 of which are included in the table herewith. Boston, New York, Philadelphia, Chicago and San Francisco are among the places not listed in the Bureau's report for Sept. 1.

Item No.	Commodity. Size and condition.	Unit.	Haverhill, Mass.	New London, Conn.	Poughkeepsie, N. Y.	Rochester, N. Y.	Buffalo, N. Y.	Baltimore, Md.	Richmond, Va.	Columbia, S. C.	Savannah, Ga.	New Orleans, La.
1.	Common brick	1,000	$24.00	$30.00	$20.00	$17.75	$23.00	$20.00	$19.00	$12.00	$14.00	$17.75
2.	Portland cement, excl. of containers	Bbl.	3.60	3.60	3.30	3.35	3.03	2.85	3.50	4.00	3.30	3.00
3a.	Yellow pine, No. 1, dimension 2x4—16′, S1S1E	M	.....	.....	.....	48.00	55.00	40.00	32.00	.....	30.00	45.00
3b.	Douglas fir, No. 1, dimension 2x4—16′, S1S1E	M	.....	.....	49.00	56.00	60.00	.....	.....	.....	.....	.....
3c.	N. Carolina pine, No. 1, dimension 2x4—16′, S1S1E	M	.....	.....	.....	48.00	.....	.....	.....	25.00	.....	.....
4.	Common boards, No. 1, 1x6	M	55.00	45.00	40.00	45.00	50.00	40.00	32.00	25.00	30.00	45.00
5a.	Y. P. flooring edge, grain "C," 1x4—10′—16′	M	130.00	.....	.....	130.00	85.00	.....	.....	100.00	.....	75.00
5b.	Douglas fir V. G., No. 2, 1x4—10′—16′	M	.....	.....	.....	.....	115.00	.....	.....	.....	.....	.....
6a.	Red cedar shingles, extra clear, 16″, 5 to 2	100 sq. ft.	6.40	6.00	.....	6.00	6.75	11.20	7.20	.....	.....	7.50
6b.	Cypress shingles, extra clear, 16″, 5 to 2	100 sq. ft.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6c.	Composition shingles, crushed slate surfaced	100 sq. ft.	.....	.....	.....	.....	.....	6.00	5.48	6.25	6.50	.....
7.	Gypsum plaster board, ⅜″	1,000 sq. ft.	50.00	50.00	50.00	30.00	45.00	32.50	40.00	37.00	37.50	45.00
8.	Lime, HYD, com	Ton	20.00	26.00	22.00	20.00	16.00	15.00	17.50	20.00	20.00	.....
9.	Building sand	Cu. Yd.	2.50	1.65	2.50	2.25	1.48	2.50	2.25	1.25	2.00	2.00
10.	Crushed stone, ¾″	Ton	2.50	.....	2.60	2.25	1.30	.....	.....	2.75	4.40	3.25
11.	Wire nails	Keg	5.00	5.05	5.05	4.25	4.25	3.75	4.05	4.25	4.05	3.75
12.	Window glass, single A, 10″x12″	50 sq. ft.	.....	4.27	.....	4.20	4.20	.....	5.80	.....	.....	4.00
13.	Hollow tile, 8″x12″x12″	Each	.30	.32	.23	.21	.21	.24	.20	.18	.....	.24
14.	Cast iron soil pipe, 4″ E. H., 13 lbs. per ft	Ton	.....	.....	.....	72.67	63.05	62.00	.....	.....	.....	75.00
15.	Steel pipe, 1″ galv	100 ft.	.....	.....	.....	10.52	10.00	9.88	10.00	11.87	9.46	9.97
16.	Reinforcement bars, ¾″ square	100 lbs.	.....	.....	4.50	3.60	.....	3.55	3.35	4.50	5.00	3.75
17.	Structural steel, fab. 6″ I beams	100 lbs.	.....	.....	5.00	4.50	3.65	3.63	4.50	4.75	5.00	3.90
18.	White lead, dry	100 lbs.	14.00	14.50	.....	12.60	14.00	.....	.....	14.75	14.75	12.50
19.	Zinc oxide, Am. process lead free	100 lbs.	.....	.....	.....	.....	.....	.....	15.00	19.00	20.00	.....
20.	Gypsum plaster, neat	Ton	.....	26.00	.....	18.00	17.00	19.50	.....	20.00	20.00	22.00
21.	Linseed oil, raw, in bbls	Gal.	1.08	1.35	.....	1.08	1.02	.95	1.12	1.15	1.00	1.15
22.	Roofing slate, No. 1 ribbon	100 sq. ft.	.....	.....	.....	15.00	.....	.....	13.50	.....	.....	15.25
23.	Tar paper, roofing, 2-ply, 75 lbs. per roll of	100 sq. ft.	3.00	.....	.....	1.80	2.00	.....	.....	.....	.....	3.50
24.	Rosin sized sheathing, 2-ply, 30 lbs. per roll of	500 sq. ft.	1.75	.....	.....	1.50	1.50	1.75	1.50	.....	1.00	1.35

	Pittsburgh, Pa.	Cleveland, Ohio	Newark, Ohio	Dayton, Ohio	Detroit, Mich.	Pontiac, Mich.	Bay City, Mich.	Milwaukee, Wis.	Waterloo, Ia.	Des Moines, Ia.	Council Bluffs, Ia.	Grand Forks, N. D.	Shreveport, La.	Tucson, Ariz.	Los Angeles, Cal.	Seattle, Wash.	Portland, Ore.
1.	$17.00	$16.00	$18.00	$15.50	$17.50	$16.00	$18.00	$13.50	$16.50	$19.00	$16.50	$15.00	$15.00	$15.00	$15.00	$18.00	$20.00
2.	3.10	3.48	3.50	3.12	3.72	.....	2.85	2.66	3.00	3.40	.....	3.80	3.20	4.40	3.36	3.00	3.00
3a.	50.00	57.00	47.50	55.00	55.00	50.00	50.00	43.00	52.00	52.00	50.00	.....	46.00	.....	.....	.....	.....
3b.	.....	.....	.....	55.00	.....	.....	.....	.....	50.00	52.00	48.00	50.00	.....	65.00	41.50	23.00	23.00
3c.	.....	.....	.....	52.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4.	47.00	49.00	50.00	.....	55.00	50.00	48.00	42.00	46.00	58.00	48.00	48.00	50.00	60.00	40.00	24.00	24.00
5a.	74.00	92.00	95.00	90.00	.....	75.00	85.00	.....	95.00	105.00	112.00	.....	.....	.....	.....	.....	.....
5b.	.....	.....	.....	.....	.....	.....	.....	.....	95.00	95.00	100.00	95.00	.....	100.00	82.75	66.00	55.00
6a.	6.25	6.00	6.50	6.20	6.40	7.00	7.00	6.25	6.50	6.75	6.25	5.00	.....	5.60	.....	3.75	.....
6b.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.75	.....	.....	.....	.....
6c.	6.25	6.20	6.75	6.50	7.25	7.00	6.00	6.75	7.50	6.00	.....	.....	7.70	.....	.....	.....	6.60
7.	37.50	.....	45.00	32.50	30.00	40.00	40.00	42.00	36.00	42.00	.....	.....	45.00	.....	35.00	35.00	36.63
8.	23.00	18.00	20.00	16.00	20.00	16.00	16.00	.....	20.00	20.00	.....	25.00	25.00	.....	26.50	22.00	.....
9.	2.50	2.50	2.50	1.75	2.75	1.50	2.50	2.00	1.75	2.00	3.50	3.00	2.25	1.25	1.75	1.85	1.35
10.	5.50	3.50	.....	2.75	2.35	.....	3.80	2.40	3.50	4.50	4.00	.....	4.32	3.00	3.10	.....	2.00
11.	3.50	.....	4.00	4.10	4.00	3.75	3.85	3.75	4.50	4.25	5.35	5.50	4.60	6.25	4.50	4.35	4.35
12.	4.80	.....	4.00	4.50	6.25	.....	5.00	4.45	5.25	4.80	.....	.....	5.10	.....	4.38	4.50	5.13
13.	.20	.....	.19	.21	.20	.18	.18	.17	.17	.....	.....	.....	.22	.....	.19	.20	.20
14.	55.00	.....	75.00	.....	64.96	.....	90.00	97.00	82.00	90.00	.....	.....	106.25	.....	74.00	95.00	91.47
15.	9.86	.....	10.40	10.50	8.50	9.00	9.75	10.50	12.00	11.25	.....	.....	11.95	14.50	12.35	14.20	12.78
16.	4.00	.....	5.00	.....	3.50	3.50	3.70	3.25	4.00	3.15	3.25	.....	4.00	6.00	4.25	3.20	3.50
17.	3.25	.....	.....	4.50	7.00	4.50	4.90	.....	4.95	5.00	3.65	.....	6.50	.....	6.95	5.75	6.00
18.	14.00	14.00	13.90	14.00	14.00	13.00	13.00	.....	14.50	14.50	15.50	18.00	15.00	15.25	13.00	11.75	13.25
19.	15.00	.....	.....	15.00	.....	.....	19.00	.....	19.00	14.75	.....	.....	.....	.....	17.00	19.00	.....
20.	22.00	.....	19.00	18.00	.....	17.00	17.50	.....	18.00	18.00	17.00	27.00	24.00	.....	.....	21.00	20.00
21.	.96	1.02	1.10	1.01	1.05	1.15	1.20	.....	1.30	1.25	.....	1.50	1.35	1.11	1.10	1.15	1.27
22.	13.50	.....	14.00	15.00	.....	17.00	17.00	16.50	18.00	18.00	.....	.....	12.00	.....	.....	.....	23.00
23.	1.95	2.50	2.25	2.25	.....	2.75	2.85	2.45	3.25	3.00	.....	.....	2.75	.....	3.50	.....	.....
24.	1.35	.90	1.20	1.50	1.40	1.00	1.20	1.65	1.50	1.50	1.40	2.00	1.40	.....	1.50	1.25	.....

Pittsburgh Steel and Iron Prices

The following data on prices and freight rates are taken from The Iron Age of Nov. 22:

Plates, sheared, tank quality, base, per lb	2.50c
Beams, channels, etc., base, per lb	2.50c
Soft steel bars, base, per lb	2.40c
Reinforcing steel bars, base, per lb	2.40c
Track spikes, 9/16 in. and larger, base, per 100 lbs	$3.15
Track spikes, ½ in. and smaller base, per 100 lbs	3.15-3.25
Spikes, boat and barge, base, per 100 lbs	3.50
Track bolts, ¾-in. and larger, base, per 100 lbs	4.00-4.25
Tie plates, per 100 lbs	2.55-2.60
Angle bars, base, per 100 lbs	2.75
Butt welded steel pipe, ¾-in.—Percentage discount—Black 60; galv.	48½
Butt welded steel pipe, 1 to 3 in.—Percentage discount—Black 62; galv.	50½
Lap welded steel pipe, 2½ to 4 in.—Percentage discount—Black 57; galv.	46½
Pig iron, No. 2X, Philadelphia, per gross ton	$22.64
O.h. rails, heavy, at mill, per gross ton	43.00

Freight Rates

All rail freight rates from Pittsburgh on domestic shipments of finished iron and steel products, in carload lots, to points named, per 100 lbs., are as follows:

Philadelphia	$0.32	St. Louis	0.43
Baltimore	0.31	Kansas City (pipe)	$0.705
New York	0.34	St. Paul	0.60
Boston	0.365	Omaha	0.735
Buffalo	0.265	Omaha (pipe)	0.705
Cleveland	0.215	Denver	1.27
Cleveland, Youngstown, comb.	0.19	Denver (pipe)	1.215
Detroit	0.29	Pacific Coast	1.34
Cincinnati	0.29	Pac. Coast, ship plates	1.20
Indianapolis	0.31	Birmingham	0.58
Chicago	0.34	Memphis	0.56
		Jacksonville, rail and water	0.415

Index Numbers of Wholesale Prices

An "index number" is really a percentage, and in the case of an "index price" shows the relative price level at different times. In the accompanying table the price level, or "index price," is 100 for the year 1913; and the indexes for other periods are those calculated by the U. S. Department of Labor.

In previous issues it has been stated that the index of building materials did not include steel. This is in error, as the revised index is a weighted average of the principal building materials including steel and certain other metals. All figures given in this table are in accordance with the revised calculation.

	Farm products.	Foods.	Cloths and clothing.	Fuel and lighting.	Metal and metal products.	Building materials.	Chemicals and drugs.	House furnish'g g'ds.	Miscellaneous.	All commodities.
1913	100	100	100	100	100	100	100	100	100	100
1914	103	102	98	98	85	92	101	100	95	98
1915	104	105	98	88	99	94	134	100	95	101
January	104	106	94	87	82	88	108	99	99	98
July	104	104	96	81	106	94	130	100	94	100
October	106	102	101	94	105	98	151	100	93	102
1916	123	121	127	126	162	120	181	106	121	127
January	110	109	110	113	138	110	84	103	110	113
April	113	114	118	120	164	120	200	104	110	121
July	117	117	125	121	158	120	175	107	120	123
October	136	134	137	128	164	124	164	109	132	136
1917	190	167	175	169	231	157	202	125	148	177
January	152	149	158	171	198	138	173	118	149	153
April	184	164	164	164	230	155	186	121	153	173
July	196	169	181	176	292	168	205	129	153	188
October	207	180	185	153	207	156	231	139	142	183
1918	218	188	228	170	187	172	215	153	156	194
January	211	182	201	164	183	161	223	137	145	184
April	213	181	220	166	184	169	228	144	152	190
July	217	185	238	175	189	177	209	159	159	196
October	225	198	245	176	192	177	211	164	163	202
1919	231	207	253	181	162	201	169	184	175	206
January	224	203	220	178	175	176	181	167	166	199
April	230	205	205	177	153	169	160	167	160	199
July	241	210	262	181	160	209	167	183	177	212
October	227	205	291	189	162	229	173	194	187	211
1920	218	220	295	241	192	264	200	254	196	236
January	247	231	339	194	175	274	189	239	194	233
April	243	238	336	231	203	300	210	242	206	245
July	233	238	300	259	202	269	212	275	203	241
October	187	201	245	280	191	240	198	271	188	211
1921	124	144	180	199	129	165	136	195	128	147
January	143	162	196	247	153	192	153	217	154	170
April	117	144	176	205	138	167	135	216	130	148
June	114	137	172	191	132	163	133	196	125	142
July	119	141	172	186	124	160	129	180	123	141
August	123	146	171	184	117	156	129	179	119	142
September	124	142	178	181	116	156	131	179	118	141
October	124	140	180	189	116	159	131	180	118	142
November	131	139	180	197	114	163	129	178	119	141
December	130	136	180	199	113	158	127	178	121	140
1922	132	139	180	220	122	169	124	176	117	149
January	132	131	176	195	112	157	124	178	117	138
February	131	135	174	191	110	156	123	177	117	141
March	130	137	172	191	109	155	125	175	117	142
April	139	137	171	194	113	156	124	175	116	143
May	132	138	175	216	119	160	122	176	116	148
June	131	140	179	225	120	167	122	176	114	150
July	135	142	180	254	121	170	121	173	114	155
August	131	138	181	271	126	172	122	173	115	155
September	133	138	183	244	134	180	124	173	116	153
October	138	140	188	226	135	183	124	176	120	154
November	143	143	192	218	133	185	127	179	122	156
December	145	144	194	216	131	185	130	182	122	156
1923—										
January	143	141	196	218	133	188	131	184	124	156
February	142	141	199	212	139	192	132	184	126	157
March	143	143	201	206	149	198	135	185	127	159
April	141	144	205	200	154	204	136	187	126	159
May	139	144	201	190	152	202	134	187	125	156
June	138	142	198	186	148	194	131	187	123	153
July	135	141	193	183	145	190	128	187	121	151
August	139	142	193	178	145	186	127	183	120	150
September	144	147	202	176	144	182	128	183	121	154
October	144	148	199	172	142	182	129	183	120	153

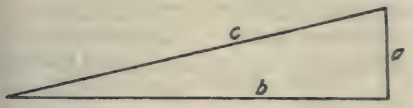
Some Easy Dodges in Mathematics

Right Triangle Solution—Square Root Extraction—Economy in Applying Ordinary Square Root Method

By L. C. JORDAN

62 Siwanoy Ave., New Rochelle, N. Y.

It is with a decided feeling of reluctance that the following simple and elementary mathematical details are brought to the attention of the readers of an engineering publication. Yet just such little matters as these, mentioned by others, have proved to be convenient time-savers to many of us. Frequently it is the extreme simplicity of a short cut in mathematics that causes it to be overlooked entirely while we adopt a laborious method which, in some vague manner, seems to be sufficiently difficult to harmonize with the importance of the case at hand. Occasionally a short and easy method will give greater accuracy than will a longer process and incidentally provide a needed mental rest in place of the nerve-racking



c-is hypotenuse b-is long leg a-short leg

Fig. 1

fatigue which results from a struggle with lengthy and bothersome computations.

Right Triangle Solution.—When we have the two legs of a right triangle and want the hypotenuse, the usual method is to square the two known numbers, add, and extract the square root. Barring errors, that will give the correct result, but it means a lot of work when the numbers are large. However, there are times when this process is the only one guaranteeing the required accuracy, and we cannot avoid it entirely, although the slide rule will save a lot of bother if properly used. Also, the laborious process may be greatly shortened by the last method mentioned herein.

In the triangle of Fig. 1 the two legs, a and b, are known and we want to find the hypotenuse, c, with reasonable accuracy by slide rule. The short and easy method is to find some value, x, by which c exceeds the longer leg, b.

$$c = b + x$$

$$c^2 = b^2 + 2\,b\,x + x^2$$

And from the triangle

$$c^2 = b^2 + a^2$$

Equating these two values of c^2 and eliminating the b^2 term, we get

$$2\,b\,x + x^2 = a^2$$

which can be used in the form

$$x = \frac{a^2}{2\,b + x} \qquad (1)$$

This equation is convenient for slide rule work, and the calculation is extremely accurate when "a" is small as compared with "b," "x" being found after a preliminary trial division. The trial value of x is added to 2 b, either mentally or on paper, and this is divided into a^2 for the true value of x. Then

$$c = b + x$$

With long, flat triangles the x value will be mainly decimal and the final result will be accurate beyond the usual needs of the problem.

When c and a are known, as in surveying where slope distances and levels are taken between stakes or spiders, the formula is similar. Here

$$b = c - x$$

and by equations corresponding to the foregoing we have

$$x = \frac{a^2}{2\,c - x} \qquad (2)$$

As an example let c = 97.642 and a = 15.685. To find b. The usual scales of the common slide rule, in order from top to bottom, will be designated A, B, C and D.

Set the indicator on the "a" value of 15.685 on scale D as close as can be read. The square of this is under the indicator on scale A and is about 246. 2 c is 195.284. Placing approximately this number of scale B under the indicator shows a quotient of about 1.260 on scale A, which subtracted from 2 c gives a divisor of 194.024. Bringing this number on scale B as

nearly as possible under the indicator shows a true value of $x = 1.268$. Then

$$\begin{aligned} c &= 97.642 \\ x &= 1.268 \\ \hline b &= 96.374 \end{aligned}$$

By squaring out and working by the usual long process, a slight variation is found in the fifth decimal place, but this is determined only after something over 20 individual figures have been set down. The simplicity is well demonstrated when the reader runs this out on his slide rule and gets the same result in less time than it takes to read about it.

When the hypotenuse and long side are known it is best to use logarithms in accordance with the method mentioned later.

Square Root Extraction.—The foregoing formulas are convenient in taking the square root of any number. When the number is large a table of squares will be an aid. Suppose we wish to find the square root of the number 138.625. In order to use formula (1), call this number c^2. b is the largest whole number smaller than c, in this case 11. Then the a^2 part of formula (1) is $c^2 - b^2$ or 17.625. And 2 b is 22. Slide rule scales C and D may be used. A trial division shows that x is about 0.80. Dividing 17.625 by 22.80 gives $x = 0.733$. Then $c = b + x$ or 11.773. By hard labor the answer is 11.773912. Let it be noted that this number was purposely chosen near the upper limit of the interval between perfect squares in order to be reasonably rough on the method. Under this condition somewhat greater accuracy could be gotten by working back from the square of 12 and using formula (2). When extreme accuracy is necessary, a table of squares should be used and one decimal figure included in the number b. In this case the square of 11.7 is used.

$$\begin{aligned} c^2 &= 138.625 \\ b^2 &= 136.890 = \overline{11.7}^2 \\ a^2 &= 1.735 \\ 2\,b &= 23.4 \end{aligned}$$

Trial value of x is $\dfrac{1.735}{23.4} = 0.074$

$$x = \frac{1.735}{23.4 + 0.074} = 0.0739$$

$$\begin{aligned} b &= 11.7 \\ \hline c &= 11.7739 \end{aligned}$$

When the "x" term of the divisor is so small as to be negligible, formula (1) becomes

$$x = \frac{a^2}{2\,b},$$

and in many cases the square rooting consists of merely setting down the answer. As an example, the square root of 122 is $11 + \dfrac{1}{22} = 11.0454$. And the square root of 627.428 is $25 + \dfrac{2.428}{50} = 25.04856$, which is wrong in only the last figure given.

Right Triangle Solution by Logarithms.—The logarithmic method of finding the unknown side of a right triangle when the hypotenuse and one side are given is easily used and also easily overlooked. Again referring to Fig. 1, let c and b have the values given in the example below. Then $a^2 = c^2 - b^2 = (c + b)\,(c - b)$. We find the logarithms of these two terms and divide by 2 for the logarithm of a.

$$\begin{aligned} c &= 94.376 \\ b &= 87.951 \\ \hline c + b &= 182.327 \qquad \log = 2.2608510 \\ c - b &= 6.425 \qquad \log = 0.8078731 \\ & \qquad\qquad\qquad\quad 2\overline{)3.0687241} \\ & \qquad\qquad\qquad \log a = 1.5343620 \\ & \qquad\qquad\qquad\quad a = 34.22646 \end{aligned}$$

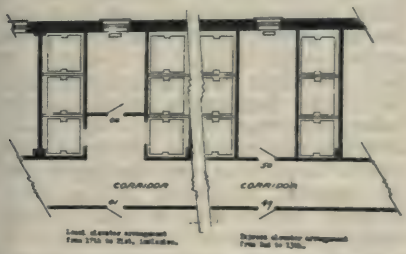
Economy in Applying the Ordinary Square Root Method.—When a square root is being taken in the usual long way of doubling the part of the answer already found and using this as a trial divisor and then annexing the new figure of the answer for a complete divisor, it would be well to remember that the last few figures of the answer may as well be derived by a modified rule which will eliminate a large proportion of the work without impairing the accuracy of the result. The usual procedure may be followed until about one more than half of the desired number of significant figures are obtained. Beyond this point the last completed divisor should be retained and the problem continued as ordinary long division. In this manner fully one-third of the work is eliminated.

While these notes are given primarily for the engineering student and for the young engineer whose work deals mainly with computations, it is hoped that they might contain helpful hints for older members of the profession.

Savings and Improvements Through General Conference

Owners, Designers, Constructors and Operators Jointly Effect Important Savings and Increase the Usefulness of S. W. Straus Building After Plans Are Completed

After acceptance of final plans for the building now under construction at the southwest corner of Michigan Avenue and Jackson Boulevard, Chicago, the builders, S. W. Straus & Co., called a conference which resulted in changes saving $250,000 on construction, increasing the rentable area, and adding to the convenience of future tenants. The original plans were recognized as having been



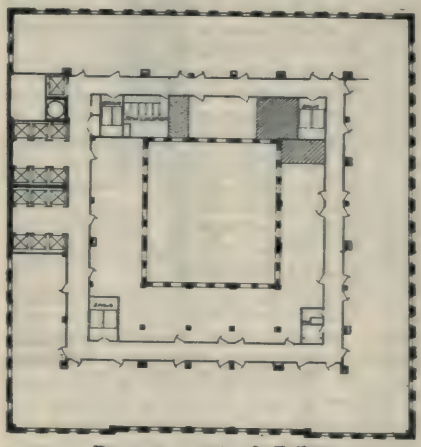
Elevator Arrangements Showing Elimination of Entrances on Certain Floors.

entirely satisfactory and creditable. The changes resulted from a conference unique in character.

The purpose of the gathering was the union of all those interested in the building, the owners, the architects, the engineers and the group of building managers, for the common purpose of determining the most artistic appearance, the greatest economy of construction and the most efficient layout of office space.

This conference furnished the first commission given the New Building Planning Service Committee of the National Association of Building Owners and Managers, of which Earle Shultz, persident of the national association, is chairman.

The other members of this committee, including the special counsel drawn in for the conference are: Clarence T. Coley, operating manager of the Equitable building, New York City; W. H. Ballard, president of W. H. Ballard & Company, building managers of Boston; W. M. MacLachlan, manager of the Simon J. Murphy Company, Detroit, owners of the Penobscot, Marquette, Telegraph and Murphy buildings in that city; M. S. Halliday, assistant vice-president of the Union Trust Company, Cleveland, whose new building is one of the largest office buildings in the world; Louis T. Clark, manager of the Wright & Callender Building company of Los Angeles; Lewis B. Ermeling, secretary of the National Association; Edward Probst, of Graham, Anderson, Probst & White, the architects of the



Rearrangement of Toilets.

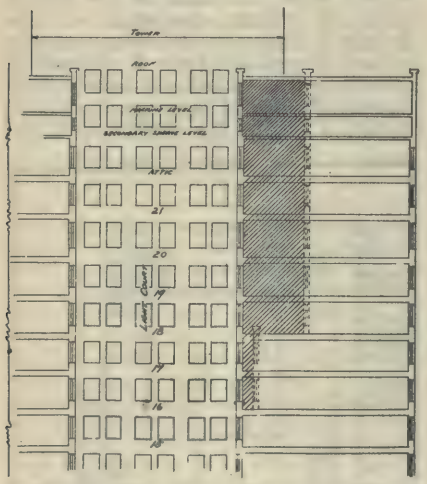
Shaded portion shows old toilet location. Dotted portion next to new location indicates the number of square feet of floor space saved, per floor, by changing toilet location. Also, note only one window used in new location. In addition, the revised arrangement makes it possible to construct a partition across the corridor indicated by dotted line and to include any portion or all of the corridor in the rentable area without affecting the accessibility to the toilet facilities.

building; R. F. Thompson, of Graham, Anderson, Probst & White; J. G. Morgan, vice-president of W. H. Ballard & Co., Boston; Col. Gordon Strong of the Republic Building, Chicago, and B. K. Read, technical advisor, Gordon Strong & Co., Chicago; L. J. Sheridan, chairman of the building committee, and O. C. Foster, western head of the Straus engineering

department, represented S. W. Straus & Co. at the conference.

The Straus executives felt that the conference would bring to bear on the plans during their very inception the point of view of the future tenants. Even though no changes in the building plans would necessarily be made, the owners felt that the bringing together of so many points of view would be highly profitable through the savings made by better and more efficient maintenance and operation.

Despite the fact that at the time of the conference the steel structural



Section Looking East, Showing Additional Gain in Floor Area by Elimination of Setbacks on South Wall of Light Court.

layout could not well be changed, the concentrated analysis of the experts resulted in a large number of constructive thoughts and suggestions relating not only to the material, the equipment and the layout of the building, but also to considerations pertaining to the operation and renting program.

The changes suggested by the members of the conference concerned largely those particulars which reflected the accumulated experience of the building managers representing the tenant point of view.

An example of the savings effected is the increase in rentable area through changes in the toilet facilities, elevator and court plans.

Instead of duplicating elevator door and signal equipment throughout the building, the corridor space between the express elevator banks on all floors from the first to the thirteenth where express cars will not stop is to be utilized for extra office space. On these floors there will be no elevator entrance doors or other expensive equipment. Above the thirteenth floor the elevator corridor space in front of the local elevators from the sixteenth to the twenty-first floor will be used for office space not previously planned. This arrangement, together with the gains made by making the walls of the interior court perpendicular instead of terraced, will add $24,000 a year income to the building.

Another saving was in the elimination of the chair rail, which has always been considered an essential for the protection of the walls from contact with chairs. As a matter of fact the chair rail does not protect the walls, because a chair usually makes a contact with the wall above or below the rail line. At thirty-five cents a linear foot, one can appreciate the amount of saving in the thousands of feet of wall in such a structure as the Straus building.

Among other savings effected are:

Elimination of sidewalk lights.

Elimination of locks on the inside office doors.

Elimination of exterior windows in elevator banks.

Elimination of one complete stack of toilets throughout the building.

Elimination of vacuum cleaning plant in favor of small portable machine.

Elimination of the setback in the court, which, at an expense of $50,000, secured additional rentable area producing an annual income of approximately $25,000.

The main shaft of the Straus building will rise to a height of 22 stories and will carry a 10-story tower. The structure will be in the form of a hollow square, built around the perimeter of the lot, with an inside light court entirely surrounded by offices. Rentable space exclusive of the six floors to be occupied by the owners will be about 400,000 sq. ft.

Results of Examination of 100 Year Old Menai Suspension Bridge

Abstract of Paper Presented Before Institution of Civil Engineers of Great Britain

By HENRY TUDSBERRY and ALEC R. GIBBS

The Minister of Transport having asked for a memorandum dealing with the question of the safety of the Menai suspension bridge, the Director-General of Roads gave instructions that a complete examination of the bridge should be made and a report submitted thereon.

The national importance of the Menai Bridge and its historical associations render it of special interest to members of the Institution; whilst the question of the methods to be adopted in investigating the suitability of old structures for modern conditions of traffic affords matter for serious consideration.

Description of the Bridge.—The bridge was designed and built by Thomas Telford in 1820-1826, and is still the only road connection between Anglesey and the mainland. The suspended span, which is 580 ft. from centre to centre of the towers, is supported by four main chains, which divide the bridge into two roadways and a centre footway. Each of the four main chains consists of four lesser chains superimposed, and each single chain is composed of five long links and six short links alternately, the links being connected by 3 in. diameter forged unturned pins. The platform is suspended from the chains by 1 in. square rods hung vertically and attached to cross girders, which in turn carry the longitudinal trough flooring. The floor as now existing weighs about 320 tons more than the original floor.

Method of Examination.—The general procedure adopted in the examination of the bridge was as follows:—

(a) Collection of information available from drawings, etc.

(b) Verification of this information and collection of further information from the site.

(c) Theoretical calculations.

(d) Detailed examination of all parts of the bridge.

(e) Extensometer measurements of existing stresses.

(f) Tests to ascertain the stresses produced by live load and impact therefrom on the various members of the bridge.

(g) Physical tests to ascertain the nature and present condition of the wrought iron.

The bridge is built of forged members made up of welded wrought iron, which, therefore, vary considerably from the nominal sizes. It was consequently necessary to ascertain the minimum dimensions of the existing links in the main chains and the exact condition of the individual members of the bridge as regards corrosion, etc.

The choice of a suitable extensometer was not an easy matter. Although the examination had been delayed until the summer to get fair weather conditions, the wind sometimes attained a speed of 40 miles per hour. When arrangements had been made for the removal of the links or for the attendance of test loads, etc., it was imperative for financial reasons, to proceed according to program, and consequently necessary to have instruments which were capable of use under unfavorable conditions and in exposed positions. Permission was, therefore, obtained of the Minister to use a stress-indicator designed by one of the authors, which appeared likely to be suitable. This instrument proved equal to all the requirements; it was simple, could be used in a confined space, was not affected by a breeze, and in windy or stormy weather was easily protected by a tarpaulin hung on the windward side.

Three complete groups of links were removed from the main chain:—(a) Near the centre of the span; (b) near the Anglesey tower; (c) over the Anglesey approach. Extensometer tests were made during both the removal of the old links and the insertion of the new links, and the stress in each link, and the total load on each group of links, were observed.

Condition of Chains and Saddles.—The chains in the tunnel were generally in good condition, but a number of badly-corroded links, both long and short, were found in the chains in the open. This condition was obviously not anticipated by Telford, as he increased the section of the chains in the tunnels by 85 per cent to allow for

loss by corrosion. The chains in the tunnel have been painted by direct labor, whilst the chains in the open have been painted by contract. The authors are of the opinion that in this case the former method is the more satisfactory, but that it is not possible entirely to arrest corrosion of the nature existing in parts of the bridge, and painting can only be considered a palliative.

The saddles are supported by turned expansion rollers, which are corroded to such an extent that they do not act in a satisfactory manner, the movement of the saddles over the rollers being only a fraction of the calculated figure. The authors point out that the absence of means of preserving the rollers from corrosion was a weak spot in early designs. It was found from observations that the dead-lead stresses are transmitted to the approach chains, but the failure of the rollers to operate prevents any live-load stresses from being carried to the chains over the approaches, and must consequently induce considerable stresses in the masonry towers. Observations with stress-indicators show that the stresses in a group of five bars forming one link may vary by 70 per cent, and are not uniform, as would be assumed in theoretical calculations. The authors consider that this is due to errors of workmanship in the forging of the pins, which were not turned. When new pins were inserted, a much better distribution of stress was obtained. Observations were made of the additional stress induced in the chain by the operation of removing and replacing links.

Recorded Stresses.—The live-load tests generally confirmed theoretical computations, the impact from traffic proceeding in accordance with the regulations—walking pace—or from a truck bumping over a 2 in. piece of timber being very small so far as the main chains were concerned. The authors summarise the stresses to which the main chains are subjected, and in this connection the following loads have been taken into account:—

(a) Dead load of structure.

(b) Live load coming on the bridge.

(c) Impact from live load striking obstructions—this has not been added to the total.

Loads rendered necessary by repairs to the bridge as follows:—

(d) Load induced by dead weight of stopper. (The stopper is the appliance used for holding the ends of the links of the chains while intervening links are removed and replaced.)

(e) Additional stress induced in chain, when the stopper is tightened up.

The following are the maximum recorded stresses, taking no account of stresses set up by wind, etc.

	Centre of bridge. Tons per sq. in.	Near Tower. sq. in.	Anglesey approach. Tons per sq. in.
(a)	7.2	8.18	8.58
(b)	0.73	0.63	nil
(c)	Not added	Not added	nil
Total (a) and (b)	7.93	8.81	8.58
(d)	0.30	0.30	0.30
(e)	1.36	1.50	1.43
Total	9.59	10.61	10.31

The recorded stresses show some variation from those calculated, as they show the effect of stresses induced by irregularities of workmanship, such as unturned pins, irregular lengths of links, etc., also the possibilities that the load is not evenly divided between the four chains forming one main chain.

The stresses in the bridge are unusually high, and the factor of safety to be considered a minimum is a debatable point. The usual factor of safety for a structure of this nature, ignoring wind-stresses, would be one-fourth of the ultimate stress or one-half of the elastic limit. Under the actual conditions it is found that in places the wrought iron is at times stressed to its elastic limit. It has to be remembered that the members of the bridge are made up throughout of welded parts, the individual bars which form the long or short lengths of the main chains having been made of piled rods; the eyes also were forged separately and then welded to the shanks. The suspenders were similarly welded.

Tests of Links.—Tests made at the National Physical Laboratory on links

removed from the main chains gave a yield stress of 13.6 to 16.2 tons per sq. in. and breaking loads of 19.8 to 24.5 tons per sq. in. The tests made to ascertain the limit of proportionality gave a mean of 10 tons per sq. in. The more important results of tests carried out by the National Physical Laboratory on eleven long links removed from the bridge are given in an appendix to the paper, with certain collated results of tests carried out on the site.

These are 796 suspenders or vertical ties in the bridge, and each of these comprises from two to six lengths. Those over the approaches only serve the purpose of maintaining the chain in the desired curve. These bars nevertheless carry a load approximately equal to the dead load in similar ties on the suspended span and, therefore, cannot be ignored.

In 1908 considerable renewal work to the bridge was carried out, the renewal of vertical ties being an important part of this work. No seriously corroded bars, therefore, were discovered on the present examination; and, where a bar was noticeably corroded, it was found to have been orginally of larger size than normal. In all cases these corroded bars are situated in the approaches and are not liable to live load, but they are, of course, liable to variation in stress due to wind-pressure.

Experience with stress-indicators on the suspension rods illustrated how difficult it was to estimate the load they were carrying by vibrating them. There is considerable variation in the tautness of the rods, and they might with advantage be adjusted by means of instruments similar to those used during the examination.

When the stress-indicator was in use on these bars during July it showed on many occasions an increase of stress of about 1 ton per sq. in. due to the wind. In considering the calculated loads coming on these rods, the vibration due to wind has to be taken into account.

Although exact details as to the quantity of traffic passing over the bridge are not available, it may be taken that approximately 2000 tons passes over the bridge daily during the summer months.

Cleaning Stone Buildings

Methods of Removing Surface Dirt Described in Stone

There is considerable literature pertaining to the cleaning, waterproofing and preserving of stone, but it is widely scattered, and is to be found only in the pages of technical periodicals. The subject has engaged the attention of scientific authorities, particularly in Great Britain, where the restoration of famous old buildings is always in progress. Much of the matter that has appeared in the English journals, however, has only a casual interest in this country, because of the difference in conditions.

The Early Stone Structures of England.—Hundreds of years ago, when many of the historic structures of England were erected, there was no scientific study of building materials, and, owing to the lack of transportation facilities, the stone nearest at hand was apt to be chosen. It is impossible to deny that much stone that would now be held entirely unfitted for building work was employed in the erection of great edifices in the past.

Under the best of circumstances the English climate is very trying to stone work, because of the presence of immense quantities of sulphurous gases in the air, due to the universal consumption of soft coal. Magnesian limestone and the softer sandstones, the materials most frequently used, have disintegrated somewhat in weathering so that the study of the restorers has been to waterproof the stone and indurate the fresh surfaces exposed. But there is also the task of cleaning off the thick crust of soot and grime accumulated in the centuries.

Cleaning Practice in England.—Old English practice has been to accomplish this by applying to the surface, with a long-handled fibre brush, a strong caustic solution of pearlash. This is allowed to remain on for about 15 minutes, and then the surface is washed several times with clear water, using a stiff brush or broom for the purpose. If this does not prove effective enough the stone is scrubbed with soft soap and concentrated lye. This is allowed to remain on until nearly dry, and then the stone is rinsed with clear water, a brush being used to remove the cleansing material. It is, of course necessary for the workman to protect his hands with rubber gloves.

In some cases, where there are large and comparatively smooth surfaces, the stone is honed with a soft rubbing stone, several varieties for this purpose being held in favor by the trade.

Different Conditions in America.—On this continent, conditions are different. Our buildings are nothing like as old, and as a rule they are erected of more durable stone, and the problem is merely to remove surface dirt and not to arrest disintegration, or to work off a thick, encrusted grime. As a rule we are not fond of an atmosphere of antiquity in our buildings; we want everything to look spick and span new. We lose sight of the fact that the mellowing influence of time is a great beautifier of architectural work.

When we cut a stone and set it in a building we seem to think that it should always retain its pristine freshness, even if the color, when it comes from the chisel, is a bit dazzling or harsh. Buildings have been cleaned when the laborous process has robbed them of a distinct part of their charm.

The first point to insist upon, therefore, in any discussion of the cleaning of stone, is to be sure that the building actually needs cleaning and will be improved thereby. Here is a case in point. A business man recently purchased a marble building in lower New York that was erected nearly, if not quite, a hundred years ago. He remodelled the interior at considerable expense, and now is distressed because the exterior isn't as bright and fresh as a new structure. And yet, the building is not stained or disfigured, and its appearance is dignified and mellowed by time. To scrape off this kindly coating, which is in reality merely a protective skin formed by nature, would weaken the resistance of the stone and prove of the most doubtful aesthetic value. It would be like dissolving off the beautiful patina from an old bronze or the iridescence of ancient glass.

Cause of Stains.—There is still another point to be made. There are buildings that are undeniably blotched and stained due to errors of construction. We have stated many times that there is no standard and approved stone used for building in this country that contains within itself the elements of staining.

Those stones which contain free iron or mineral elements that change and discolor the surface have fallen into disfavor and been rejected. Every stone, however, is more or less absorptive and can take into its pores discoloring matter with which it is brought into contact. Portland cement, for instance, will always stain stone, and unless stone can be set in lime mortar, the back, beds and joints of each block must be thoroughly covered with a protective paint. But even so, some of the discoloring moisture may find its way to the pores of the stone and work by capillarity to the surface. Or the water from concreting within the building may flow down the exteror, thus occasioning staining.

Scrupulous care will prevent these accidents, and the standard specifications, issued by the Indiana Limestone Quarrymen's Association, give full directions, by which they may be avoided. If, however, there is staining of this nature, the best remedy is time. Sunshine and the weather may generally be depended upon to restore the stone to its natural color.

The use of acid for cleansing is always to be deprecated. Sufficiently diluted and applied with extreme care, it may do no harm, but it is a dangerous expedient to entrust to the ordinary workman, and it may burn the stone so that its last state is worse than its first. Under no circumstances should sand-blasting be permitted. Stone always indurates on the surface by exposure, and sand-blasting removes this protective coat and shortens the natural life of the stone. Wire brushes should never be used in washing down a building, for these will inevitably cause rusting.

Scrubbing Best Method of Cleaning.—The experience of the most careful and observant stone contractors has been that the best method of cleaning any kind of stone building is a thorough scrubbing. Prepare a wash of soft water and about one and a half bars of common laundry soap. Boil until the soap has been thoroughly dissolved. Add a fine, clean, gritty sand (white, preferred), and mix to about the consistency of putty. While mixing, add about 5 tablespoons of ammonia per bucket of water. With this preparation scrub the surface with a stiff fibre scrubbing brush. Wash down with a stream of water from a hose, and then go over it again with the scrubbing brush.

Method of Making Sgraffito Decoration

The exterior sgraffito decoration has been used for many centuries as a means of architectural embellishment; its more general use today is perhaps avoided in smaller work because of an unwarranted belief that the process is a complicated one and that the expense of execution prohibitive. In addition, an element of uncertainty as to lasting quality sometimes is held by those who have not made use of its very colorful possibilities. Some interesting information on this form of decoration is given by S. Brian Baylinson, associate Frank E. Hahn, architect and engineer, in Philadelphia, in Contractor's Atlas, from which we quote as follows:

Many of the old Italian sgraffito facades subjected for centuries to the excessive heat and heavy rainfall of Italian climate, bear witness to the fact that sgraffito work, properly executed, is most lasting and durable. This is true in a great many cases, where on the same building stone and marble show decided signs of deterioration.

It is surprising how much can be done at a comparatively small expenditure. The splayed panel forming the entrance motive to the Bains Luggage Shop, here illustrated, cost $400, exclusive of the structural foundation.

If proper materials are embodied in the specification, such as a good pure white stainless portland cement, a true even coloring compound and a substantial foundation, together with capable workmanship, a most satisfactory result is assured.

The following short specification has been found to be a very satisfactory one:

Erect backing of expanded metal lath and channels, including all rod hangers, etc., required to amply support same.

Then apply scratch coat of cement mortar composed of Atlas white non-staining cement and screened washed white, sharp sand, evenly applied and scratched. Apply a second coat of Atlas white non-staining cement and white sand as above, evenly applied and left ready for finishing sgraffito work.

Upon the cement plaster base apply one coat of cement plaster composed of Atlas white non-staining cement and screened white sand thoroughly washed and sharp.

This coat to be ¼ in. thick, evenly

Store Front With Sgraffito Decoration.

applied and tinted a warm sienna using an approved color pigment.

Before this tinted coat has entirely set, apply a coat of cement plaster composed of Atlas white cement, white, sharp sand, thoroughly washed, and marble dust. Place the stencil previously cut over background prepared as above and carefully trace design shown, removing all cement coating outside of design and back to and exposing the ground or sienna first coat, leaving design in relief. The surfaces of the design to be given sufficient scratch modeling to avoid harsh lines. Do not, however, make the mistake of modeling design, as this will entirely destroy the character of the ornament.

Building Construction in Japan

A large building construction company is being organized in Tokyo for the purpose of undertaking the construction of commercial and industrial buildings on the unit basis, says a report received by the Far Eastern Division of the U. S. Department of Commerce from its representative at Tokyo. This company plans to specialize in 4-story reinforced concrete buildings designed to withstand earthquake shocks. Such material as cannot be obtained locally or which cannot be supplied in standard specifications will be obtained abroad, it is announced.

Funds for the promotion of this new company will, according to present plans, be obtained in large part from the government at a low interest rate. At present the company is marking time awaiting the announcement of the plans of the Capital Restoration Board as to the areas set aside for industrial and business purposes, etc.

The announcement of the general plans for reconstruction as worked out by the Reconstruction Board are expected any day. Meanwhile, temporary construction is in progress in a big way in Tokyo and Yokohama, but permanent building is, of course, being delayed until after promulgation of regulations designating industrial and commercial zones, height of buildings, materials to be used, etc.

It appears at present that in addition to securing abroad a large part of the iron and steel and lumber that goes into the permanent reconstruction, considerable quantities of cement will have to be imported as well. Ordinarily Japan exports considerable cement but the enormous demand that is bound to come with the commencement of permanent building activities, coupled with the destruction of about 8 per cent of Japan's cement production, will be greater than the industry can meet.

The annual capacity of Japan's cement mills was, before the earthquake, in the neighborhood of 14,000,000 bbl. and plans are under way which will, within six months' time, bring this up to 17,000,000 bbl., notwithstanding the losses suffered by the earthquake. Until such time as this increased output is brought about, it is expected that the domestic supply will be inadequate and that considerable cement will have to be imported. In anticipation of this need, the government has placed cement on the free list effective until March 31, 1924.

Conservative bankers in Tokyo are advocating a program of reconstruction spread over a period of 20 years and financed in most part through the flotation of domestic loans. In order to keep the yen on an even keel, however, they favor the flotation of foreign loans sufficient to cover all purchases made abroad.

Rate of Drying of Wall Plaster

The U. S. Bureau of Standards receives numerous inquiries as to when plaster can be painted safely. A careful study of this subject led to the conclusion that plaster can be painted safely when dry. The next question is how long does it take plaster to dry? This is of importance, not only as regards painting, but also in the erection of wood trim, and because of its effect on the general speeding up of construction. A slow-drying plaster may cause financial loss to the contractor because of delay in completing the work, and it may cause loss of occupancy to the owner. Plans have therefore been made to measure the relative rates of drying of different kinds of plaster under different atmospheric conditions. The equipment necessary for this research has been designed, and is now being made in the bureau's shop.

Strength of Steel I Beams Haunched with Concrete

Report of Investigation Conducted Under Direction of F. P. Sherwood, Chief Engineer Dominion Bridge Co., Given in August Journal of the Engineering Institute of Canada

The object of the investigation was to study the strength and behaviour of steel I-beams supporting a reinforced concrete slab and haunched with, or encased with concrete, for the purpose of protecting the steel from fire, or corrosion. While such beams have hitherto been designed on the assumption that the entire load, including the weight of the encasing concrete, is carried by the steel, it was thought that the steel and concrete might really act together so as to form a composite beam, and that it might be practicable to arrive at some rational basis for design analogous to that employed in the case of reinforced concrete T-beams.

With this object in view, two identical floor panels were built in the erecting shop of the Dominion Bridge Co.'s plant at Lachine. Each panel consisted of a reinforced concrete slab 10 ft. by 16 ft., and 4 in. thick, reinforced by wire mesh. This slab was supported by two 10 in. I-beams, weighing 22.25 lb. per lin. ft. (Carnegie B. 67), and 16 ft. long. The beams were spaced 5 ft. centre to centre and were connected at their ends, by means of standard connections, to girders consisting of 24 in. I-beams 15 ft. long. The latter rested on concrete pedestals placed about 14 ft. centre to centre. Ten in. channels, parallel to the floor beams, connected the ends of the girders and served to hold them in place. Further, in order to provide convenient bridges for measuring the deflections of the floor beams, two 5 in. I-beams were provided, attached to the main girders, some 8 in. away from the beams. Inasmuch as these small beams were connected at each end to lugs on the girders by a single machine bolt, and the heavier channel connections were 4 ft. 8 in., away from the floor beams, it will be seen that the girders were practically free to accommodate themselves to the deflections of the floor beams, and that the latter were therefore subjected to very little end restraint.

The top flanges of the floor beams projected 1 in. into the concrete slab, while the concrete haunching, projecting 2 in. below the bottom of the lower flange, and varying in width from 9½ in. at that point to 11½ in. at its junction with the slab, gave a minimum protection of 2 in. to the steel. For a length of 2 ft., however, at the centre of each beam, the concrete was removed from the lower flange in order to make it accessible for attaching extensometers and other measuring instruments.

Program of Tests.—The program of tests originally outlined was as follows:—

(a) Establish points for strain gauge readings on the bottom flanges of the floor beams before erection.

(b) Take strain gauge readings at these points after erection, but before any additional load is applied.

(c) Apply a uniformly distributed load equivalent to that of the concrete to be placed subsequently, and measure the deflections and flange stresses.

(d) Apply a further uniformly distributed load sufficient to bring the flange stresses to about 16,000 lb. per sq. in., and measure the deflections and flange stresses.

(e) After the concrete is poured and cured, measure the flange stresses due to the weight of the concrete.

(f) Apply the same uniformly distributed load as in (d) and repeat the measurements of flange stress and deflection.

(g) Apply additional load, if required, to bring the flange stress to 16,000 lb. per sq. in.

After the first six items of this program were completed, the resistance of composite beams proved so high that it was thought advisable to extend it considerably.

Method of Loading.—All loads applied were made up of structural steel shapes, which had been previously weighed. So far as possible uniform sizes were used for each load increment, the units in this case being uniformly distributed. When uniform sizes were not available, the shapes used were placed according to a predetermined plan so as to maintain practically the same relations between the resulting bending and shearing forces as would be due to a uniformly

distributed load. The equivalent uniform load was calculated in such cases with reference to the bending moments produced at the centre of the span. Great care was taken at all stages to avoid the possibility of any arching effect. Furthermore, the beams in the bottom layer were placed on blocks offset alternately 10 in. on each side of the centre lines of the floor beams, so as to cause a negative bending moment in the slab over the beams practically the same as that which would be caused by a load uniformly distributed over the entire surface of the slab.

Before application, the shapes were placed in correct position on timbers packed up on either side of the test panel. Loads were then readily applied and removed by raising and lowering the jacks.

Measuring Apparatus.—Deflections were measured by an ordinary micrometer caliper. For flange stresses, mirror extensometers of the Martens type covering 4 in. gauge lengths were placed on each edge of each flange. These instruments read to hundred thousandths of an inch, and experience shows that, when used with the proper precautions, they are unsurpassed for sensitiveness and reliability. A 10 in. Howard gauge was used as a check, and also solely, to measure the stresses due to the weight of concrete, for which purpose mirror extensometers could not be used. For the use of the Howard gauge three parallel lines of measurement were established on each bottom flange at the centre of the beam. These two methods checked each other very satisfactorily, as will be seen from the comparison given in Table II. The stresses indicated by the mirror extensometers were, however, adopted as likely to be more accurate. In reducing extensometer and strain gauge readings, the modulus of elasticity (E) was assumed to be 30,000,000 lb. per sq. in.

Observations on the beams before concreting were made on Nov. 25th, 1922. The loads and calculated stresses and deflections are shown in Table I.

The resulting stresses and deflections as observed are given in Table II.

The discrepancies between the calculated and observed stresses may be due to any one or more of the following causes:—(a) Variation in section of steel from nominal section. (b)

Table I.—Loads, Calculated Stresses and Deflections.

Stage of loading	Loads—lbs. Per sq. ft. of slab	Loads—lbs. Per beam	Bending moment In—lbs.	Flange stress lbs. per sq. in.	Deflections Ins.
Panel No. 1					
b. I-beams	4.48	358	8,590	380	.....
c. Concrete equivalent	75.4	6,030	144,720	6,370	0.167
d. Live load	106.8	8,550	205,200	9,030	0.237
Total applied load	182.2	14,580	349,920	15,400	0.404
Total load	186.68	14,940	358,510	15,780	.....
Panel No. 2					
b. I-beams	4.48	358	8,590	380	.....
c. Concrete equivalent	74.8	5,990	143,760	6,320	0.166
d. Live load	110.75	8,860	212,640	9,360	0.245
Total applied load	185.55	14,850	356,400	15,680	0.141
Total load	190.0	15,210	364,980	16,060	.....

Table II.—Stresses Before Concreting.

Stage of loading	Calculated flange stress lbs. per sq. in.	Observed flange stress: Mirror Extens. Stress	Mirror Extens. Pct.	Howard Gauge Stress	Howard Gauge Pct.	Deflections Calculated in.	Deflections Observed in.	Pct.
Panel No. 1								
c. 75.4	6,370	6,210	97.6	6,525	102	0.167	0.162	97.0
d. 106.8	9,030	8,610	95.5	8,800	97.5	0.237	0.233	98.3
182.2	15,400	14,820	96.5	15,325	99.5	0.404	0.395	98.0
Panel No. 2								
c. 74.8	6,320	6,450	102	6,250	99	0.166	0.166	100
d. 110.75	9,360	8,625	92	8,400	89.8	0.245	0.227	92.6
185.55	15,680	15,075	96.1	14,650	93.5	0.411	0.393	95.7

Variation in modulus of elasticity of the steel from assumed value. (c) Errors in observation. (d) End restraint. (e) Errors in estimating and placing the load.

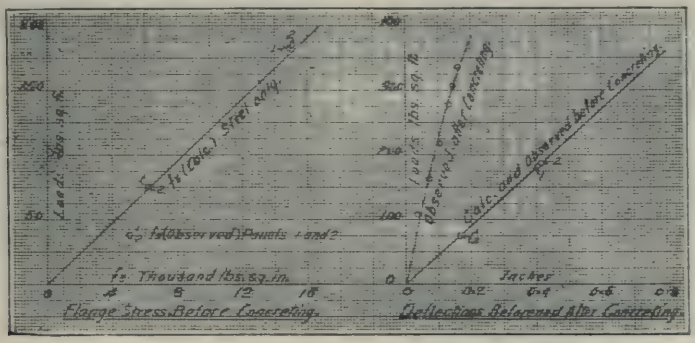
As regards the above results the largest discrepancy between observed and calculated values is in the case of the live load of 110.75 lb. per sq. ft. in panel No. 2. As all other results are very consistent and well within the limits of error which might be expected, it seems probable that the live load on panel No. 2 was really a little less than estimated.

The above results are shown graphically in Fig. 1.

Tests of Concrete.—The concrete was poured by the Foundation Co., Ltd., of Montreal. Three-quarter inch run of crusher limestone, and local river sand were used. The mix was 1:2:4. The cement was furnished by the Canada Cement Co. The concrete for panel No. 2 gave a slump test of about 4½ in. but that for panel No. 1 was somewhat wetter. The instructions were to make a good ordinary commercial grade of concrete, without taking any special precautions. The mixing, however, was probably rather better than is usual. Panel No. 2 was poured on Dec. 4th, and panel No. 1 on Dec. 5th. Four cylinders 6 in. by 12 in. were moulded from concrete taken from the mixer, as used in panel No. 2, and cured alongside of the panels, and under the same conditions. Cylinders Nos. 1 and 2 were tested at McGill University on Jan. 6th and cylinders Nos. 3 and 4 at the University of Toronto on Jan. 13th. The result of these tests were as follows:—

	Lb. per sq. in.
Cylinder No. 1 ultimate strength	3,800
Cylinder No. 2 ultimate strength	3,100
Cylinder No. 3 ultimate strength	3,630
Cylinder No. 4 ultimate strength	3,400
Average	3,480

All cylinders were crushed between squares of commercial beaver board without other preparation. The forms were suspended from the floor beams, so that the dead weight of the concrete, forms, and excess water, if any, was carried by the steel beams. The slight deflections due to the weight of the forms, etc., would not be fully recovered after the removal of the latter when the concrete was set. The permanent dead load flange stress in the beams was therefore likely to be slightly greater than that due to the weight of the concrete alone, and the results given below indicate that this was the case. On the other hand, the concrete would be free from dead load stress, a favourable condition, so far as the concrete is concerned, for taking care of live loads. There would also be no appreciable bond stress developed by the dead load.



Figs. 1 and 2.—Flange Stress Before Concreting and Deflections Before and After Concreting.

After the concrete had set for about three weeks, Howard gauge readings were taken on the bottom flanges for the purpose of measuring the flange stress due to the weight of the concrete. The results were as follows:—

Stress due to weight of concrete panel No. 1—7,050 lb. per sq. in.

Stress due to weight of concrete panel No. 2—6,450 lb. per sq. in.

Average 6,750 lb. per sq. in.

As may be seen from Table II, this is about 400 lb. per sq. in. greater

than either the estimated or observed stresses due to the "equivalent concrete load." Inasmuch as the concrete in place was actually weighed and found to agree practically with that estimated, the discrepancy may be due in part to lack of precision in the Howard gauge measurements, but probably in a greater degree to the considerations mentioned in the preceding paragraph. It is believed that the average value, 6,750 lb. per sq. in., is a close approximation to the truth, and is adopted in tabulating and plotting the results.

Live Loads Applied.—On Dec. 28th, when the concrete in panels No. 1 and No. 2 were respectively 23 and 24 days old, live loads were applied and stresses and deflections measured as before at each stage. The results are given in table No. 3, stages "e" to "h", in which the dead load stress and deflections are taken as zero.

A few hair marks, in the concrete, which were first visible at stage "g", extended at stage "h" to about 5 in. above the bottom flanges of the I-beams. Each load was applied and removed several times. A permanent set of about 0.01 in. in the deflection first appeared after stage "h", the extensometers giving a corresponding indication. Panel No. 2 was loaded only to stage "f" showing, as indicated, lower flange stresses and deflections than panel No. 1.

Vibration Test.—As it was thought advisable to try the effect of vibration, a concrete mixer, weighing (with its charge of 500 lb., of stone) 10,400 lb., was next placed on slab No. 1 and run for two days at a good speed, compressed air being used in the cylinders. The load was concentrated on a length of 3 ft. 9 in., over each beam, giving a bending moment at the centre of the beam of 18,400 foot-pounds, which corresponds to a uniformly distributed load of 115 lb. per sq. ft. Howard gauge and deflection readings taken before and after the running of the mixer, checked the weight of the latter, but gave no other result. The hair cracks previously noted showed no further extensions, although the amount of vibration produced would have been quite excessive in a building. On account of the short duration of this test, however, it must be regarded as inconclusive.

The live load of stage "h", 216.8 lb. per sq. ft., was then replaced on panel No. 1 where it remained for five days. During this time, a few hair cracks in the haunching extended about 3 in. further, or to about 1 in. from the bottom of the slab. On Feb. 12th addi-

Table III.—Stress and Deflections After Concreting.

Live load lb. per sq. ft.	Flange stress lb. per sq. in. Calc. steel only acting	Observed Extensometer	Pct.	Howard gauge	Deflections Calc. steel only acting	Observed	Pct.
Panel No. 1							
e. dead load	0	0		0	0	0	
f. 106.8	9,030	2,830	31	3,090	0.237	0.042	18
g. 161.8	13,700	5,125	37	.....	0.358	0.071	20
h. 216.8	18,350	7,670	42	.....	0.482	0.103	21
k. 272.2	23,100	9,650	42	.....	0.605	0.133	22
l. 304.9	25,800	10,980	43	.....	0.678	0.144	21
m. 333.4	28,200	12,465	44	.....	0.741	0.162	22
n. 365.3	30,800	14,755	48	.....	0.812	0.191	24
Panel No. 2							
e. dead load	0	0		0	0	0	
f. 110.75	9,360	2,190	23	2,610	0.245	0.035	14

Table IV.—Summary of Observed and Calculated Stresses, Panel No. 1.

Stage of loading	Load lb. per sq. ft. Inc.	Total	Flange stress lb. per sq. in. Calc. for steel only Inc.	Total	Observed Inc.	Total	Pct. Obs. Calc.
a. On skids	0	0	0	0	0	0	
b. Erected	4.5	4.5	380	380	380	380*	
c. Concrete Equiv.	75.4	79.9	6,370	6,750	6,210	6,590	97.5
d. Live load	106.8	186.7	9,030	15,780	8,610	15,200	96.5
b. Erected		4.5		380		380*	
c. Concreted	75.4	79.9	6,370	6,750	6,750	7,130	105.2
f. Live load	106.8	186.7	9,030	15,780	2,830	9,960	63.2
g. Live load	55.0	241.7	4,650	20,430	2,295	12,255	59.8
h. Live load	55.0	296.7	4,650	25,080	2,545	14,800	59.1
k. Live load	55.4	352.1	4,680	29,780	1,980	16,780	56.5
l. Live load	32.7	384.8	2,760	32,520	1,330	18,110	55.8
m. Live load	29.8	414.6	2,520	35,040	1,485	19,595	56.0
n. Live load	32.0	446.6	2,720	37,760	2,290	21,885	58.0

*Not observed.

tional loads were applied, and the usual observations made. The results are given in Table III, stages "k" to "n", the stresses and deflections due to the dead load stage "e" being again taken as zero.

The calculated and observed stresses due to dead and live loads combined are given in Table IV.

As it was impracticable to apply more load satisfactorily, the test was discontinued. No further cracking was perceptible, nor sign of approaching failure, other than the fact that the flange stresses were increasing slightly more rapidly than the load.

The above tests indicated, we believe, that the steel and concrete in the form of construction tested act together so as to produce a composite beam. The marked similarity in behavior to that of a reinforced concrete beam was quite striking to those having experience in testing the latter.

Stresses in Welded and Riveted Steel Tanks

The results of an investigation carried out last winter by the U. S. Bureau of Standards on stresses in welded and riveted steel tanks under hydrostatic pressure have now been published as Technologic Paper No. 243, for sale at the Superintendent of Documents, Washington, D. C., at 5 ct. per copy.

Four steel tanks, 4 ft. in diameter and 10 ft. long, made of 5/16 in. mild steel plates, and designed for a stress of 16,000 lb. per square in at 200 lb. working pressure, were used in these tests. Two of the tanks were butt-welded, one was lap-welded, and the fourth was of the ordinary lap-riveted construction. The ends of the tanks were spherical, having a radius of 4 ft.

Strain gauge measurements were made at various portions of the tanks and at pressure increments of 50 lb. per square inch until failure. The results of the hydrostatic tests proved rather unsatisfactory as a comparison of the relative strengths of the different types of construction. Due to secondary failures, such as leaks around the fittings, the possible strength of the tanks was not reached. In fact, the secondary failures were responsible for failure in each case. In one tank the failure was at the weld around a 2-in. pipe outlet; in the second, at the manhole; in the third, at the end transverse weld, and in the riveted tank at the end transverse riveted joints. The first two failures might have been obviated by better welding of the pipe fittings and manhole saddle to the shell. Extra reinforcement at the junction of the spherical end to the cylindrical shell would have reduced the stresses at the junction where the other two tanks failed. The location of the end transverse seam or riveted joint farther back on the shell of the tank would have taken this joint out of the region of high stress intensity caused by the abrupt change in direction of force at the junction of the spherical end of radius 4 ft. to the cylindrical shell of radius 2 ft.

According to a recent Technical News Bulletin of the Bureau of Standards, the results of the analysis of the deformation and distribution of stress in these tanks seem to warrant the following general conclusions:

1. The commonly accepted theory for the design of tanks is, for all practical purposes, sufficiently accurate, provided the computed stresses are not influenced by secondary stresses.

2. For thin tanks, the measured stresses, based upon the two-dimensional formula, are in close agreement with the design stresses computed by the common-pressure formulas, provided the former are not affected by secondary causes. This is borne out by the results obtained at the center of the end.

3. Secondary stresses resulting in high stress intensity were caused by (a) faulty design of the attachment of the spherical end to the cylindrical shell, (b) non-conformity of the shell to an accurate circular section, and (c) discontinuities in the shell for the manhole and fittings. These may produce a possibly dangerous condition if present near a welded or riveted joint seam.

4. The stresses were increased by the presence of a seam.

Annual Meeting of General Contractors.—The next annual meeting of the Associated General Contractors of America will be held Jan. 21 to 24, inclusive, at Chicago, Ill.

Some Notes on Pile Foundations

Occurrences Encountered by Bureau of Yards and Docks Described by Public Works of the Navy

By CAPT. GEO. A. McKAY

In driving piles in soft material it repeatedly happens that sufficient initial bearing resistance is difficult to secure, but that after the piles has set for a period the grip or setting of the material around the pile will have increased its driving resistance sufficiently to permits its acceptance. The same effect is quite frequently encountered when driving in harder material, so that engineers are apt to take it for granted that this phenomenon of increase in resistance and capacity after rest is positive and will occur in all cases. The reverse of this, however, is sometimes the case, as is illustrated by the following example of piles driven for a concrete pier at the navy yard, Charleston, S. C.

Where Increased Capacity Did Not Follow Rest.—The original test piles were of round timber, with 7 in. points, and were driven through mud into and through blue clay to depths of from 70 to 80 ft. below mean low water, with final calculated bearing values of about 27 tons each. The depth of water was from 12 to 25 ft. Contract, as awarded, contemplated the use of concrete piles 18 in. square, driven to take a load of 40 tons. The contractor expected these piles to run approximately 70 ft. in length, of which about 64 ft. would be below mean low water and 6 ft. above.

In order to test assumption before concrete was molded, 18 in. square wooden test piles with 8 in. points beveled back 2 ft. 10 in. were driven. It was found that these developed a bearing resistance of over 40 tons at depths of from 43 to 57 ft. below mean low water, at which depths the resistance was such as to amount to practical refusal. It was observed, however, that when driving was resumed after a rest of from three hours to two days, there was a marked decrease in bearing resistance. In specific instances the decrease was from 43 tons to 21 tons, 42 tons to 28 tons, 45 tons to 32 tons, 47 tons to 39 tons, and 39 tons to 25 tons.

This effect was undoubtedly due to the large blunt points, which, when driven through the rather stiff clay, developed a high local resistance which was dissipated as the clay at and below the point adjusted itself to the disturbed condition of internal stress. The loss of bearing resistance at the point was manifestly greater than the increase of friction resistance of the material setting against the parallel sides of the pile.

On the basis of the tests made, the contractor proceeded with a molding of piles 70 ft. long, with 8 in. points beveled back 4 ft. The three of these first driven developed only 23 tons resistance at a depth of 65 ft. The change in the beveling of the point was effective, however, and the decrease in bearing resistance experienced with the wooden piles was not noted upon resumption of driving on the concrete piles. One of the latter was tested under a load of 100 tons, and settled only about ⅛ in.

Increasing Bearing Area by Timber Battens.—To avoid the necessity of molding concrete piles longer than 70 ft., with a resulting large increase in cost, it was decided to increase the bearing area of the lower portion of the pile above the point by bolting on timber battens. The length chosen for the latter was 10 ft. Five test piles were driven, three carrying two 6 by 12 in. timbers each, one with two 8 by 12 in. timbers, and one with two 8 by 12 in. and two 12 by 12 in. built-up timbers.

The driving of these piles resembled somewhat that of the wooden test piles, in that after they were permitted to set and driving was resumed there was a marked decrease in the resistance to penetration last obtained. It was found, however, that their bearing improved steadily with increase in depth, and when the later bearing values were plotted they presented a consistent and satisfactory curve. The final construction was successful, and the increased expense for longer piles was avoided through this use of lagging.

In general, the piles lagged with two 6 by 12 in. timbers brought up at above 40 tons at elevation—55, and after redriving dropped back to not less than 40 tons at above elevation—65. The pile with two 8 by 12 in. timbers gave correspondingly increased resistance, and the pile with four timbers, after redriving, gave 80 tons resistance at elevation—50. The entire series of tests was very interesting, and not only indicated the necessity for careful consideration of the shape of pile and point and its effect upon the apparent resistance as calculated by ordinary pile formulæ, but also the considerable saving which is possible, when driving in material such as fairly stiff clay, through the use of lagging near the base of the pile to obtain desired resistance. Where such lagging is used, however, its effects on control of length and on final bearing value of the pile, as indicated by deferred driving, should be carefully investigated.

Sometimes insufficient thought is given to the size of points for test piles. Instances have been known where test piles had points as large as 11 in. It is difficult for contractors to estimate from such tests what would be the length of piles required where the specification for the construction allows points as small as 6 in. in diameter.

Bearing Resistance Increased by Lagging Piles.—At places where considerable pile driving in soft material is common, necessity has brought about a more or less common practice of lagging the piles at or near the bottom to increase bearing resistance, but at other locations where soft driving is only occasionally encountered, engineers are unaccustomed to such an expedient and are prone to look upon it with suspicion. It is believed that the cost of structures could occasionally be reduced with no sacrifice of stability by an intelligent use of lagging with piles. Whether the lag members should be at the bottom of the pile, or above, or staggered, or of large or small size, opens up an interesting field of investigation. In general, it is believed that best results can be obtained by not concentrating all of the lagging at one point, though in particular instances the disposition would depend upon the character of strata penertated.

Many cases arise in which batter or brace piles, and sometimes vertical piles used in deck construction, in quay walls, and in narrow piers are intended to function as tension members; that is, to act under certain conditions of shock and stress as ties. Certainly the use of lagging in such cases near the bottom of the piles would be of benefit. At one yard in particular, where rock is at the surface of the bottom, it is possible to hold piles in place only by surrounding the points with rock-filled cribs. This is another case where lagging near the point of the pile would be of assistance in securing stability.

Splicing Creosoted Piles.—Dolphins are frequently required in very soft ground off the ends of long piers in locations where creosoting of the timber is necessary to protect it from teredo. The greatly increased expense of treating the very long piles necessary under these conditions often becomes a matter of concern. It has been found economical in such cases to splice the piles using an uncreosoted bottom section, with point of splice located at from 10 to 15 ft. below the mud line. The lagging used in splicing the piles increases their usefulness, and in cases where they are driven on a batter and are so framed at the top as to bring tension in certain ones when the dolphin is struck by a ship, additional lagging at the bottom of the uncreosoted section would also be of benefit.

When pipes are to act as tension members it is further necessary to give consideration to the closeness with which they are to be spaced, the depths to be penetrated, and the capacity of surrounding material to resist the pull which will develop. One of the causes contributing to the trouble experienced on the Pearl Harbor dry dock project in 1913 was the fact that the piles were so closely spaced and driven to such a shallow bearing that the pull to which they were subjected from hydrostatic and overturning pressures was more than sufficient to lift them with all of the surrounding soil.

Piles Spliced From Short Lengths.—In buildings where ground floors have settled and there is insufficient head room to drive long piles, the use of piles spliced from a number of short lengths will sometimes afford a satisfactory solution to the prosecu-

tion of repair work. Such a problem arose in the cases of a boat shop and a joiner shop at the Mare Island Navy Yard, where sections only about 13 ft. long could be handled under the second floor, whereas piles about 35 ft. long were required to secure the desired bearing. Here the stiffness of subsoil was such that dowels only were needed at splices. The buildings were in part located over a filled-in marsh on a portion of which there was a heavy layer of old sawdust, later filled over with mud and soil. The floors had settled in places a foot or more; the permanent wet line was 7 or 8 ft. below the floor level. To avoid the heavy expense of concrete piers extending to permanent wet line, the top section of each pile was made of cast-in-place concrete. The last driving for each was performed with a heavy pine follower about 20 in. in diameter at the top and 16 in. at the bottom, around which was placed a sheet-metal casing. On pulling the follower, the casing was left driven and the surface of the ground shaped to form a conical head, giving a combined column capital flare and beveled drop-panel effect corresponding in usefulness to that employed in modern flat-slab construction. The reinforcing in this top section extended into the flat slabs forming the floor, and proved to be a very economical form of construction, inasmuch as it obviated the use of beams and girders, with resulting expense for excavation and form work, and likewise the great difficulty which is experienced in placing reinforcement in excavated trenches of this nature, where the movement of men and materials throws down quantities of mud and débris, making it expensive to keep the work clean.

Splicing Concrete and Timber Piles.—The splicing together of concrete and timber piles is an important innovation which is at present receiving something of the attention which it merits. It has become necessary, in certain localities, to extend pier construction to points where satisfactory bearing for piles is not found above elevations 150 ft. or so below mean low water, and where exposure to damage from marine borers and the necessity for permanent construction requires the use of reinforced concrete piles. Entire concrete piles of this length become too heavy and too expensive to handle, and the bureau has recently been led to adopt for such purposes a type of composite pile embodying concrete above and uncreosoted timber below, with the splice formed by a section of 15 in. diameter steel pipe. This pipe is cast on the concrete section, which is driven to full bearing on the predriven timber pile.

It is not necessary, however, to limit this built-up type to conditions so severe as those just described. It can be used to advantage under certain circumstances where the pile length is much shorter, as in the case of reconstruction of dike No. 9 at Mare Island, where the mud is near the surface and long piles are required for bearing and for tension. Tension through the splice is secured through the use of bolts, lag screws, indents in pipe, and through the swelling of the timber, when wet, inside the pipe sleeve. Composite pile construction, where a reduced length of reinforced concrete can be used near the top, is more permanent and actually more economical than construction with creosoted piles.

Lateral Stability of Piles in Soft Mud.—Insufficient weight is sometimes given to the lateral stability of piles in general and the composite pile in particular, when driven in soft mud. One's first thought on seeing the pile penerate 15 or 20 ft. into such a bottom under its own weight is that the material at or near the surface is so 'soupy" as to afford practically no resistance to side movement of the upper part. It will be found, however that the resistance is surprisingly large. This will be better appreciated when consideration is given to the difference between the resistance offered to the point of a shaft when falling and the drag of any medium against its broadside exposure when the attempt is made to move it horizontally. It is found that even in soft mud, when the pipe splice connecting the concrete pile with the timber beneath is only about 5 ft. below the surface, the sidewise restraint is sufficient to develop the full strength of the concrete member at a level just below the mud surface. Engineers who have broken off wooden piles in a soft mud bottom will recall a like experience.

The nature of the lateral forces acting must, of course, be taken into

account. The lateral resistance of a silty medium against sudden shock is more effective than the force it could develop against a lower and steadier pull, but even the latter is effective in greater measure than ordinarily supposed. At Puget Sound there were recently made certain tests of the lateral resistance of piles driven in soft mud to support concrete caissons for a heavy pier. The wooden test piles penetrated under their own weight through 25 ft. of soft mud, and an additional 10 ft. under the weight of the 3,700-lb. hammer; the construction piles, under the weight only of the pile hammer and follower (18,300 lb.), penetrated a depth of about 50 ft. Yet such piles showed a resistance of 5,000 lb. to initial displacement at the surface of the mud.

Lateral Displacement of Structures in Pile Driving.—Engineers usually come to understand early in their experience the need of giving careful consideration to lateral displacement of adjacent structures as a result of pile-driving operations. They likewise quickly learn to make allowances for the upheaval of mud or softer soils. Notwithstanding this, it is doubtful if full appreciation is had of the internal stresses created in the soil in the vicinity of the pile being driven. This point was brought sharply to the attention of all concerned in the case of the driving of sheet piles on a quay wall at Mare Island. This wall had moved outboard in such a way that the old sheet piles, which were 50 ft. long and exposed to a 25 ft. depth of water, were 4 ft. outboard at the top and practically fixed at a level just below the mud line.

In the reconstruction of the wall it was proposed to place new 12 by 12 in. piling just inside the old, which meant driving through about 25 ft. of soft mud, where, on the outboard face, there was but the sheet pile and a thin layer of mud for the support of each new pile. The unbalanced pressure developed on this side was so great that it proved to be absolutely impossible to hold the tops of the old piles, no matter how many cables and chains were attached and secured to anchors. The entire scheme of reconstruction had to be changed on this account.

The original quay wall mentioned above had been injured as a result of the collapse of a side cut of a dry dock being constructed adjacent to it. The slide had carried away a number of the back brace piles of the wall, and the loss of these was unknown until after the dock was completed and filling resumed against the wall, which then moved steadily outboard. An extension of the wall at the south end had been constructed as part of the dry dock contract, after the slide had occurred, and was intact. On this section, which was designed for 30 ft. depths alongside, the sheet piles were at the back of the platform, about 40 ft. from the face of the wall. To all appearances an excessive number of brace piles had been used in this section, there being five for each cap under the relieving platform, with the caps on 4 ft. centers. Nevertheless, this section of the wall also moved outboard nearly 2 ft., and when excavation was made for purpose of repair it was found that instead of the heads of brace piles bearing against the caps there was in some cases as much as an inch clearance between the two parts. This condition at first appeared inexplicable, as it was not seen how so great a movement of the wall could have occurred without bringing the brace piles into action even had they been badly framed originally. The explanation, however, is simple. This wall is situated at a place where the silting process is very heavy. The sheet piles, as stated, were at the back, so that silting occurred under the relieving platform. When routine dredging operations were carried on along the face of the wall, the piles held back to some extent the bank of accumulated mud beneath. The brace piles were 56 ft. long and driven through soft mud with only about 3 ft. penetration in the underlying hardpan. The weight of deposited mud gripping both standard and brace piles had the effect of loading them to a degree sufficient to cause their points to settle, with the result that the brace piles acted as ties and tended to pull the wall forward.

Effect of Progressive Settlement of New Fill on Piles.—It is to be remarked that engineers often drive piles through new fill without realizing that the progressive settlement of the latter will, by skin friction, add its weight to the piles and overload them. This fact will, in itself, explain

certain cases of settlement where apparently the piles as originally driven gave ample bearing resistance for all anticipated conditions of loading. In driving through made ground, care should be taken that the piles are long enough, are big enough at the point, and penertate underlying hard bottom a sufficient distance to carry the added load imposed by the settling fill.

This principle has a clear application to the case of the new Navy Building in Washington, D. C., where an area in the headhouse about 200 ft. in length has settled to a maximum of about 4 in. The loads on the piles at the face of the building and under the interior piers are conservative, whereas piles under the piers at points where the wings at the rear meet the headhouse are overloaded. The piles are driven on a fairly recent fill over a marsh area. It would be anticipated that those piers whose piles are overloaded would settle more than the others, but this is not the case. It is the fill itself which is settling. Additional piles of the same length under the interior columns and under the front face of the building would probably have been of no benefit in reducing the movement. The trouble here is, primarily, short piles in conjunction with fill settlement.

Unusual Example of Lateral Resistance.—An unusual example of lateral resistance occurred in the driving of wooden piles for crane-track foundations adjacent to the dry dock at Pearl Harbor. Excavation for the dock left the banks, which were of coral and tufa rock, standing at a very steep angle, and the location of the crane track was over this bank upon a fill of stiff coral which had been pumped in between the bank and the wall of the dry dock. The points of the piles as driven through the coral would hit the steep side of the cut at varying depths, but it was expected that the resistance developed by the coral fill would hold the points in position to secure satisfactory penetration. This proved to be generally the case, but in the driving of one pile which was 55 ft. long, after more than 40 ft. of penetration, with driving still going fairly easy, the point of the pile was observed to break upward through the ground at a spot 18 ft. from the butt. Hammering was continued as a matter of curiosity until a length of 4 ft. had been exposed. The point was not broomed and was apparently uninjured, but had encountered some series of obstructions which had bent it in a curve about 25 ft. in diameter. Had it been possible to hold the point of this pile, the butt would probably have served its useful purpose of carrying a share of the crane-track structure.

Foundation Construction on Coral.—Probably no other material on which we have to found structures is so difficult, on account of its irregularity, as is coral. The navy designed, about 25 years ago, a coaling wharf for Tutuila, Samoa. Because of the exposure to marine borers timber could not be used, and as it had not yet become the practice to use concrete for the purpose, piles were made of solid steel, 6 in. in diameter for the wharf perimeter and 8¾ in. for the interior. It was proposed to screw these into the coral, and cast iron screw shoes about 3 ft. in diameter were sent out with this in view. Evidently the thought of the designer was that the coral was of a regular and not too hard consistency, so that the piles could be screwed about 10 or 12 ft. down into this material, and the 3 ft. spread on the shoes would give sufficient bearing resistance against settlement. The irregularity of the coral on the inshore end, however, was so great that only a few of the piles could be placed in this manner. Large compact masses were encountered, some of which were so solid that, when broken, they had the appearance of marble, and gave evidence of their characteristic coralline structure only when examined under the magnifying glass, whilst immediately adjacent to some of these were areas where the coral consisted of broken branches, partly cemented together and partly filled with mud and sand, but with not much greater bearing value than would be found in a pile of brush. To screw a pile into the side of a boulder of the hard material was, of course, out of the question, and in those locations where piles could be easily screwed into position to the anticipated depth of 12 ft. it was found that they would not hold up overnight the weight of the hammer, but would settle in some cases 2 or 3 in.

It became necessary to change the program of construction entirely,

which was none too easy a task at such a distance from the nearest market for material. The wharf was slightly relocated so as to bring the central portion of it over a site where, with the piles spliced, rock could be reached. The rock contour was followed down to a depth of over 80 ft., and the two ends of the pier were floated on cast iron mushroom shaped circular bearings. These varied in diameter from 5 to 8 ft., according to the loads to be carried. They were brought to bearing on the surface of the coral under the blows of a 5,000 lb. hammer falling about 2 or 3 ft. Some 10 or 12 ft. of an iron pile projected through the mushroom bearing into the coral below for lateral stability. The mushroom disks were secured to the piles by means of split plates bolted to the top of the disk and inserted in a circumferential groove cut in the pile. Where a disk failed to bring up in bearing, the pile would be lifted, a layer of broken coral shingle placed under the disk, and driving resumed. In some cases it was necessary to do this several times before satisfactory bearing was obtained. When the piles showed refusal under the repeated 2 or 3 ft. blows of the 5,000 lb. hammer, driving was stopped. Heavy blows of the hammer were not practicable because of the danger of breaking the cast iron disks, several of which broke even in handling, as a result of internal stresses in castings and lugs. The wharf as finally completed is still giving good service, and no settlement has been reported.

Illustrating the irregularity of the coral in this instance are the following examples: When testing to locate the underlying rock contour, soundings were made by means of an improvised rod composed of old shafting and pipe sections churned up and down by eight men on a double-deck raft. In some cases coral shell boulders or coral crust would be encountered near the surface, through which the rod would not penetrate. The operation would be shifted a few feet with the same results, and then a location might be found within several feet of the point where original attempts were made, where the rod could be easily churned down 80, 90 or 100 ft. In driving the piles for the central portion of the wharf it was found useful, first, to break through the upper coral crust, where encountered, by using a 6 in. solid pile about 37 ft. long. On two occasions when this pilot pile was being driven in about 10 or 12 ft. of water, with an approximately equal penetration into the coral, the impact of the 1,700 lb. hammer, iron on iron, falling 15 ft., would produce additional penetrations of only about ⅜ in. per blow. Considering the effect of the hammer striking the iron pile without any cushioning effect whatsoever, and bearing in mind that the bottom of the pile was pointed, this small penetration is an indication of how hard are certain portions of the mass of solid coral. On each of these two locations, conditions being as above stated, upon striking a further blow the pile disappeared; that is, it broke through into what was practically a cavity below, so void of supporting power as to lead the observers to liken it to a vacuum, such was the rapidity with which the pile vanished. On these occasions it was necessary to dredge 8 or 10 ft. in order to expose enough of the pile head to secure a chain to withdraw it. Engineers who have not as yet worked in coral should be careful not to trust this material unless its character has been carefully investigated.

U. S. Government Specification for Water-Resisting Red Enamel

Circular No. 146 of the U. S. Bureau of Standards, which may be obtained from the Superintendent of Documents, Washington, D. C., at 5 ct. per copy, consists of the latest U. S. Government Specification for Water-Resisting Red Enamel. The specification was prepared by the technical committee on paints of the Federal Specifications Board after careful consideration of suggestions from manufacturers. Highest quality red enamel suitable for outside use is called for. This consists of pure toluidine red toner in a vehicle of the very best water-resisting long oil spar varnish. A general description of the enamel is followed by detailed directions for sampling and testing, including tests for caking in container, working properties, color, hiding power, weight per gallon, coarse particles and skins, identification and determination of pigment, non-volatile matter, drying time, water resistance, and toughness.

Rental Charges for Construction Equipment

Method of Computation Outlined in The Constructor

By STANLEY STOKES,
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A rental charge should include the total cost of owning a machine plus a reasonable profit on the rental transaction. The question as to how a rental charge should be built up is fundamentally a question as to the cost of owning the equipment. Having obtained this cost, we then add a profit on the rental transaction and have the total amount which should be obtained as rental. There then remains only the problem of the best and most practical way of distributing this charge. Therefore the problem can first be examined with respect to the cost of ownership.

The several items constituting the cost of ownership are as follows: Interest on original investment, taxes and insurance, depreciation, maintenance, general expense and profit.

Let us now examine each of these items more in detail.

Obtaining the Money.—Under the heading of interest we must include the total cost of obtaining money. This cost varies considerably, depending upon the nature of the loan, whether a short-time bank loan, a real estate mortgage, a bond issue or various other possibilities. The nominal rate of interest is not sufficient to cover all expenses. For example, on a bank loan, the interest is usually figured as a discount. Thus if you pay 6 per cent for $100, the $6 is deducted in advance and you obtain $94. This is at the rate of 6.38 per cent. If you make a real estate loan, you usually have a commission of 3 per cent on a 3-year loan, or at the rate of 1 per cent per year plus title examination and recording fees, which with a nominal rate of 6 per cent makes your money cost about 7¼ per cent. If you borrow money in the form of a bond issue, you have some legal expense, brokerage charges, printing expense and other items which add from 2 to 3 per cent to the nominal rate.

Thus, a 5 per cent bond issue may cost you 1 per cent to make the issue, with brokers' fees of 2 per cent and an additional 1 per cent for printing and other items, leaving you a net amount of $96 out of each $100 worth of bonds. You pay 5 per cent on the $100 or $5 per year, for which you receive the use of $96, making your interest rate 5.2 per cent. This would represent an extremely high grade security. Considering all these items, a fair interest in normal times for short-term money would probably be not less than 7 per cent. It should be noted here that it makes no difference whether you borrow the money in a small amount for a particular construction machine or whether you have a certain amount of borrowed money in total for the business sufficient to furnish working capital and buy machinery as needed. The latter is more properly the way to regard it, so that the proper interest rate for a construction machine would be the same as the average total cost of money for the business.

Taxes and Insurance.—Taxes as such are too familiar today, no further discussion being required. In a city, the usual personal property tax rate is about $2.50 on each $100 of the assessed valuation. The average assessment for the life of the equipment probably would not exceed 40 per cent of its original cost. Automobile trucks and similar equipment may be assessed higher, but would be offset by the lower rates on other equipment. However, a frequent error is to assume that personal property taxes are all that should be considered. For example, other taxes are auto license, chauffeur's license, contractor's license, engineer's license, capital stock taxes and, above all, income taxes for both State and Federal Government. Due to the fact that the contractor turns over his investment frequently, the income tax when expressed as a percentage of invested capital must necessarily be numerically large. An investment of your own particular taxes expressed as a percentage of your invested capital may surprise you, if you have never carried out the computation.

The Insurance Item.—The amount of insurance carried by the contractor on his equipment will vary witn the nature of his business and the character of machinery in use. This item will include fire insurance, boiler insurance, collision and public liability on auto trucks, etc. A study of your own premiums will show you how much you should include for the various classes of equipment owned and rented. Workmen's compensation or employes' liability insurance is not to be included, but considered an overhead expense on the pay roll.

A fundamental concept which must be grasped in order to properly analyze the problem of depreciation is that of continuity of the original investment. This means that the total original investment must be considered to be outstanding continuously. If you want to be able to use a steam shovel, someone must be standing that investment, whether you own it, buy it. If such a shovel in your organziation or others is to be available, whether you rent it, or whether you then someone has an investment in that shovel to the amount of its original cost. To some who feel differently about this problem and would like to consider the original investment as constantly decreasing throughout the life of the equipment, we ask that they be patient with us until we have completed this discussion.

Depreciation Includes Many Losses.—Depreciation in its broadest sense includes all losses in worth arising from physical or functional deterioration by current maintenance. Depreciation arises from the following causes: Wear and tear, obsolescence due to new inventions and advances in the art, inadequacy, and catastrophies not insurable—i. e., extraordinary contingencies, floods, etc.

A depreciation reserve is necessary to maintain the original investment intact. In other words, the depreciation reserve plus salvage value of the property should always equal the original cost. In this connection, it becomes necessary to explain what is meant by salvage value. This value is either (a) scrap value, or (b) resale value at the end of a predetermined period. For example, the salvage value of a heavy engine such as the Corliss engine is usually taken as the scrap value of its component parts. It is presumed that the engine will run until either worn out or other circumstances force it to be replaced. It usually has no resale value and the most that can be realized is its scrap value. On the other hand, an automobile truck is used for a few years and sold before it is completely worn out. The second-hand market value of such a truck is faily well determined depending on its age. It makes no difference which type of salvage value is used, the difference between this value and the original cost being the total amount of depreciation. In computing allowances for depreciation reserve, the "depreciation base" to be used is the "wearing value." That is, original cost less salvage value.

Distribution of Depreciation.—The question of the preservation of invested capital being temporarily conceded, the problem becomes that of the distribution of depreciation as part of the cost of the output of service. Public service commissions in all states and the Interstate Commerce Commission consider depreciation as an operating expense which should be regarded as any other operating expense. Section 214 (a-8) of the 1921 U. S. Income Tax Law provides that in computing net income: "A reasonable allowance for exhaustion, wear and tear on property used in the trade or business, including a reasonable allowance for obsolescence should be made." The Federal Trade Commission says that depreciation is the most important overhead expense. (Fundamentals of a Cost System for Manufacturers, July 1, 1916, page 12.) The Missouri Supreme Court calls depreciation "invisible rot" (Home Telephone Co. vs City of Carthage, 235, No. 644). This last is offered to offset the idea frequently suggested that certain physical property which is in perfect operating condition is just as valuable as though it were new, inasmuch as it performs the function for which it was acquired. It is obvious that at some time it will cease to perform this function and that during this interval it will change from a valuable machine to one of no value. The only logical way to regard this change is that it took place at a uniform rate. This concept has to be modified in connection with renting equipment, but is considered as a part of the subject of depreciation. Modification will be discussed later.

A Practical Application.—As a practical application, let us assume the following examples:

Original cost of the machine	$1,000
Salvage value at end of 5 years	250
Wearing value to be depreciated	750
Average depreciation per year	150
Per cent per year of the original cost for depreciation only	15%

At this point it should be mentioned that there are various methods of setting up depreciation reserves which are known as straight-line methods, sinking fund methods, and others. These will be referred to again.

Maintenance expense includes all repairs or replacements of part of the unit so that it may continue to operate at as nearly its original efficiency as possible. The amount of maintenance depends solely on the type of the machine and has to be estimated from records of similar machines over a period of years. In addition to ordinary repairs, after each extended period of service, a general overhaul is usually required. This is a proper charge to maintenance. For example, if a machine be rented, even though the renter agrees to maintain the machine in working order at his own expense, still the owner should give it an overhauling when he gets it back, knowing that the only maintenance that the renter will give it is that necessary to keep it in operation.

What General Expense Includes.—General expense which includes expenses of general office, general supervision not properly chargeable to individual jobs, office rent, stationery, printing, postage, and other such items, which are computed from experience as a percentage of the preceding total, in figuring a construction estimate, are likewise applicable to construction equipment. These expenses can be readily determined for a particular business. Such expenses may fluctuate widely as between different contractors, due usually to a different method of bookkeeping rather than to any economy which one may obtain over the other. That charge specific work with a greater percentage of the overhead expense than another. For the purpose of this discussion, without attempting to specify a correct amount, we shall use 10 per cent of the total preceding expenses as a fair overhead expense.

Profit on money invested in construction machinery should be computed at that rate which would be considered reasonable for the business as a whole. This profit, together with interest paid for the use of money, is usually combined and referred to as "return on investment." The determining factor which fixes a fair rate of return is the risk of the business. Whereas 4 per cent may be sufficient return on Government bonds, 20 per cent may be low for a speculative enterprise.

Suppose that, without in any way attempting to state what is a fair return on money invested in the contracting business, that for an illustration we assume 10 per cent. Restating our original example, then, we have:

Original cost of machine	$1,000
Life	5 yrs.
Salvage	$250
Interest	7%
Taxes and insurance	5%
Depreciation	15%
Maintenance	8%
	35%
General expense (10% preceding total)	3.5%
Cost of ownership	38.5%

The figure of 8 per cent maintenance was assumed to have been estimated from previous experience on this machine. Thus in this hypothetical case we find a total cost of ownership of 38.5 per cent per year of the original cost of the machine. This would not be sufficient for an annual rental, but to that would have to be added a small profit on the rental transaction itself, which we might take as 3 per cent, making a total annual rental of 41.5 per cent.

This cost of ownership goes on continuously whether or not the machine is being used, and it is fair to assume that the depreciation takes place uniformly whether or not the machine is in service. Actually, the depreciation is more likely to take place more rapidly in non-use than when the machine is in service. The cost of owning such a machine per working hour is entirely a function of the number of hours worked. If we may define the load factor on the machine as to the ratio of the hours' use per year to the total hours in the year, then a machine which works half of the time would have a load factor 50 per cent. The cost for the working period would then be the total annual cost divided by the load factor. Thus it is seen

that a most economical operation requires continuous use of the machinery. This immediately suggests "Off Peak" rates for rental of construction equipment during period of the year when the machine is not working. This will be discussed in more detail under rentals.

Depreciation Reserves.—There are several methods whereby a depreciation reserve may be set up, of which the three following are most important:

Sinking Fund Method—The amount set aside plus interest compounded annually is such that this sum will equal the original investment at the expiration of the life of the equipment.

Reducing Balance Method—The reducing balance plan charges off a constant percentage on the decreasing balance. This balance is obtained by subtracting the previously accumulated reserve from original cost. Such process is continued until the value has been reduced to that of salvage.

Straight Line Method—A uniform percentage is set up each year throughout the life of the equipment. No allowances made for interest on accumulated reserve.

For detailed discussion of each plan reference is made to "Depreciation —Principles and Applications," by Earl A. Saliers, 1922 Edition, published by the Ronald Press Co., New York. Briefly, it may be said that the straight line method has the advantage of simplicity; probably gives as good a picture of the manner in which depreciation takes place as any of the other methods; the accuracy of apparently more refined methods is academic rather than real, as the error in assumption of probable life is so great that a refinement in interest charges is miliar to measuring the first 5,279 ft. with a 2-ft. rule and the last foot with a micrometer. Further, the simple method lends itself readily to a revision of the percentages set up to comply with experience. Particularly is this true for short life equipment.

As as example, on a $1,000 equipment having an assume life of 5 yrs. the sinking fund reserve would be 94 per cent of the amount required for straight line basis. Thus an error of 6 per cent in the assumed life would offset this. In the case of a water works with a major investment in cast iron with a life of 50 yrs., the sinking fund method should perhaps be used. The reducing balance method was adopted and used to some extent in England, but rarely in this country.

Determining Rental Price. — As stated in the beginning, the rental charge should include the cost of ownership plus a reasonable profit. Having determined the cost of ownership and outlined the basis of a reasonable profit, the rental problem reduces to that of finding a practical method which will obtain the necessary revenue over the period of the life of the equipment and at the same time distribute these charges in such a way as to be able to rent the machine in a competitive market. For example, inasmuch as the renter is likely to stand the cost of repairs while he is using the machine, he would be willing to pay more for a new machine than for an old one, although both machines are in good condition. Also, he might anticipate fewer breakdowns in a few months than in an old one. For this reason it seems desirable that the rental for such a machine be made higher during the earlier years of its life. In this connection, it may be noted that the maintenance in the earlier years would be less and vice versa. Thus a varying rental would result to some extent in the renter paying the same total cost throughout the life of the machine. Referring to our previous illustration in which our depreciation was 15 per cent per year for 5 yrs., we might revise this for rental purposes as follows. First year, 25 per cent; second year, 20 per cent; third year, 15 per cent; fourth year 10 per cent, and fifth year, 5 per cent, for a total of 75 per cent.

This plan would probably appeal to the renter. It would be conserative in that it carries a depreciation reserve much faster than the straight line method. However, the rates for the early years should not be selected too high. In this connection it might be mentioned that a new company having a large investment in construction machinery might not be able to make such heavy charges against its revenue without affecting its ability to pay dividends and thereby impair its credit. In other words, the straight line method of setting up the reserve seems desirable from the standpoint

of owning the machine and of determining the total amount which must be derived when it is rented. The variable charge can be used merely as a means of establishing a rental charge, this latter method being a practical modification to meet competitive conditions.

Again referring to our example, with an annual rental of 41.5 per cent on a $1,000 machine or $415, we reconstruct this on a varying basis as follows:

	1st year	2nd year	3rd year	4th year	5th year
Interest	7%	7%	7%	7%	7%
Taxes and insurance	5	5	5	5	5
Depreciation	25	20	15	10	5
Maintenance	5	5	8	10	12
Preceding total	42	37	35	32	29
Gen'l expense (10%)	4.2	3.7	3.5	3.2	2.9
Profit (3%)	3	3	3	3	3
	49.2	43.7	41.5	38.2	34.9

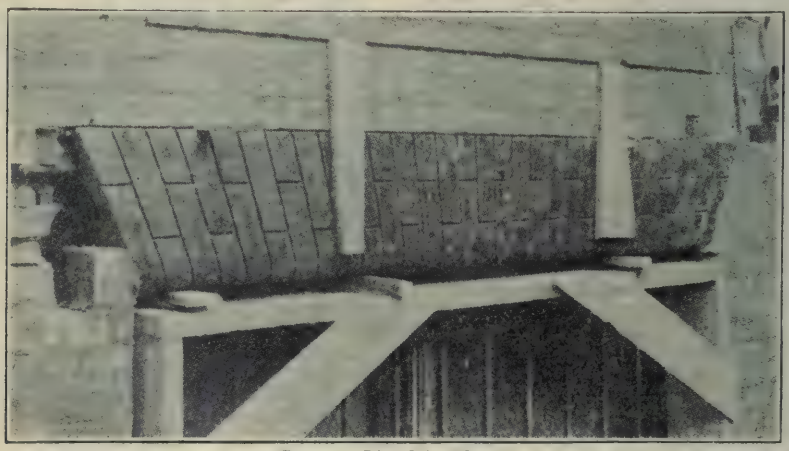
For comparison we would collect rental as follows by the two plans:

Year	Uniform Rate	Variable Rate
1	$415	$492
2	415	437
3	415	415
4	415	382
5	415	349
	$2,070	$2,070

It is apparent that the total annual cost of a machine is approximately a constant regardless of use and therefore increased use results in decreased cost per working hour. Thus reduced rates could be calculated for any off peak use which would serve to increase the normal use. It may also be noticed that for a machine costing $1,000 with an annual rental of $415 that if it is used for 30 days in the year, that the cost per working day is $13.86. If spread over six months, this reduces to $2.31.

Concrete Lintel in Brick Walls

On a building in lower New York, where some alterations and repairs necessitated changing some of the window openings, it was necessary to place several lintels over window openings in the old brick walls. To do this in the ordinary way would have been quite troublesome, and the easiest solution was to employ an ingeniously molded concrete lintel. One of these lintels being set in place is shown in the illustration. The precast concrete is colored with mineral pigment to stimulate almost exactly the color of the old brick work. Joints are cast in the concrete, and after the lintel is fixed in place, these joints are pointed up with mortar to match the old joints. In the illustration the joints are not yet pointed. In this case the brick walls are not bearing walls, but if they were the lintel could easily be made of such dimensions and so reinforced as to give all the necessary structural strength. We are indebted to the Contractors' Atlas for the above information and illustration.



Concrete Lintel in Place.

Membership of American Society for Testing Materials.—The American Society for Testing Materials on Nov. 1 had 3,400 members.

The Strength of Concrete

Its Relation to the Cement, Aggregates and Water

By ARTHUR N. TALBOT

Professor of Municipal and Sanitary Engineering and in Charge of Theoretical and Applied Mechanics

and

FRANK E. RICHART

Research Assistant Professor of Theoretical and Applied Mechanics

Bulletin No. 137 of the University of Illinois Engineering Experiment Station, issued October, 1923, and bearing the above title and authorship, contains 116 pages of exceedingly interesting and valuable matter. The bulletin does not lend itself to condensation, and its extent precludes its reprinting in full in Engineering and Contracting, but in order that our readers may themselves judge of its character and scope, we give herewith its introduction and conclusion. The price is 60 ct.

Introduction

1. The Problem.—How to proportion the ingredients in designing concrete mixtures, is an important question. How much cement, how much sand, how much gravel or broken stone, and how much water must be used to secure a specified strength in the concrete or a specified workability with the particular materials that are to be used? What is the weight or the bulk of each ingredient required to produce a certain volume of concrete in place? How may the concrete-making properties of various sands and other fine aggregates be compared, and how may acceptance tests of aggregates be specified? For what sort of mixtures is a given sand suitable? As compared with some standard mix how much cement is necessary when an inferiorly graded fine aggregate is used? In the effort to increase the mobility of the workability of the freshly mixed concrete, what effect do increased amounts of mixing water, or decreased amounts of coarse materials, or changes in the gradation of the aggregate, have upon the strength and other properties of the concrete? What is the upper limit of the amount of coarse aggregate which may be used when the particles are all well rounded particles and also when there is a preponderance of elongated particles? What is this upper limit of the amount of coarse aggregate when the pouring and placing are around reinforcing bars, and also when the concrete is placed in larger masses? These are some of the questions connected with the problem of designing concrete mixtures for definite purposes.

Many views have been put forth concerning the factors which govern the strength of concrete, and quite divergent opinions have been advanced. A variety of methods of dealing with the problem have been proposed—the use of the sieve analysis of the fine and coarse aggregates, either separately or in combination; limitations in the amount of the fine aggregate coming within a given range of sizes; conformity to a given form of sieve-analysis curve; properties based on the gradation of the particles of the aggregates as indicated by sieve analyses, such as fineness modulus and surface area; the amount of mixing water used and its relation to the amounts of the cement and the aggregate; percentages of voids in the aggregate and in the concrete, etc. Most authorities on concrete are in accord with the principle that, other things being similar, within certain limits the strength of concrete increases with the quantity of cement used and with the density or solidity of the resulting concrete, though in recent years statements have been made quite frequently which seem to throw doubt on the truth of this principle and to discredit the earlier writers. Altogether, there has resulted considerable confusion in the minds of engineers as to what constitute the real influences in the makeup of concrete, and as to proper ways for specifying the quality of the aggregates and for proportioning the mixtures.

2. Scope of Bulletin.—This bulletin enunciates relations between the compressive strength of the concrete and the amount of the cement and voids

contained therein. It develops methods for studying the concrete-making properties of fine and coarse aggregates and for the comparison and acceptance of aggregates. It outlines means for designing concrete mixtures for different densities and strengths when the voids in mortars made up with a given cement and fine aggregate have been determined by laboratory tests. Means are suggested for estimating the effect upon the strength and density of concrete that accompanies an increase in the amount of mixing water beyond that which would give minimum volume to the concrete. Analytical relations are developed and the technique for the proposed tests described. The results of tests of mortars and concretes made up with a variety of fine aggregates are recorded and the accuracy and applicability of the methods discussed. It is found convenient to use the absolute volume of the ingredients in terms of a unit of volume of the concrete in place, and for this purpose the specific gravity of the material should be known. The resulting values may readily be translated into bulk or weight when the voids or bulk weights of the materials in the condition obtaining on the work are known. The method is proposed for use in estimating the density and strength of concrete and in proportioning the materials. The test data cover a considerable range—a variety of aggregates, different proportions of cement, and different amounts of mixing water—and the significance of the results is discussed. The application of the methods and principles deduced to design, specifications, and field use is considered. The usefulness of the method as a means of proportioning mixtures, calculating quanties of materials, making comparisons and estimating strengths is brought out.

The water content relations of the mortars and concretes are given in terms of that amount of mixing water which results in producing the minimum volume in the concrete, this basis being found to be more definite and satisfactory than others which have been used. Little use has been made of the expression "consistency of concrete" (a term that from its derivation means stiffness or ability to withstand change of form), since this expression is very indefinite. The flow table and the slump test were used to give some measure of mobility and workability of the concrete.

3. Principles and Methods.—The following paragraphs are given to outline some principles affecting the relation of the ingredients to the strength and density of the concrete:

(1) Definite quantitative relations exist between the magnitude of the voids in the concrete in place (water and air voids) and the compressive strength of the concrete, the quality and quantity of the cement and the quality and nature of the aggregate remaining the same, but the gradation of the aggregate varying, and other conditions remaining similar. The percentage of voids may, therefore, be taken as an index of the strength of the concrete in such cases.

(2) If concretes be made up with differing amounts of cement in such a way that the voids in the concrete remain the same, the nature of the aggregate and other conditions also remaining the same, the strength of the concrete will vary with the amount of cement used.

(3) For different amounts of cement and different gradations of the aggregate, the quality of the cement and the quality and nature of the aggregate remaining the same and other conditions remaining similar, the strength of the concrete varies with the ratio of the amount of cement used in a unit of volume of concrete to the voids in this volume, and the strength may be taken to be a function of this cement-voids ratio. Instead, the ratio of the voids to the cement may be used. In some respects it is still better to consider the strength of the concrete as a function of the ratio found by dividing the absolute volume of the cement by the sum of the voids in the concrete and the absolute volume of the cement—a ratio that may be termed the cement-space ratio.

(4) If the amount of mixing water be varied in such a way as to change the bulk of the concrete, the strength will still be a function of the cement-voids ratio of the resulting concrete, though the function may differ from that which applies with the smaller water content. When there is much difference in the relative water contents, the value taken from a strength curve based on minimum volume of concrete may be multiplied by a coefficient corresponding to the given relative water content.

(5) For the usual concrete mixtures—at least, for those that make an easily worked concrete, including all mixtures used on construction—the bulk of the coarse aggregate is less than the bulk if the concrete; or, in other words, the bulk of the mortar in a given volume of concrete is greater than the voids in the coarse aggregates alone—the term mortar being used here to include the cement, fine aggregate, and water. For such mixtures the voids in the concrete may then be considered to be made up of the water and air voids in the mortar. The density of the mortar for the consistency used in the concrete is, therefore, an important factor in determining the strength in the concrete.

(6) If the amount of the water and air voids in the mix of mortar to be used in making the concrete is known (the term mortar here meaning the combination of cement, fine agregate, and water which enters into the concrete), the voids in a resulting concrete may be calculated and the corresponding cement-voids or cement-space ratio

may be used as an index of the strength of the concrete.

(7) By determining the voids in mortars made with a given fine aggregate, but with varying proportions of cement, a characteristic mortar-voids curve giving the relation between the voids in mortar and the ratio of fine aggregate to cement may be made up for any given fine aggregate, and information will then be available on which to base calculations for voids and strength of concrete made with definite proportions of cement, fine aggregate and water.

(8) By determining the voids in various mortar mixes made with different fine aggregates of the same character and thus obtaining characteristic mortar-voids curves of the given fine aggregates, comparisons may be made of the relative densities and probable resulting strengths of concrete made up with these mortars and with assumed volumes of coarse aggregate.

(9) Knowing the characteristic mortar curve of a fine aggregate, the general nature and quality of the aggregate otherwise being known, the proportions of the mix required to give a specified strength (including the amount of cement, fine aggregate, and coarse aggregate) may be calculated with a fair degree of accuracy.

(10) The foregoing principles and methods are most readily applied by the use of the absolute volumes of the cement, fine aggregate and coarse aggregate; but if the voids in the fine aggregate and the coarse agregate in a dry state or in the condition obtaining on the work are known, or the relation between the weights by bulk and by solid volume, the bulk of the fine aggregate and the coarse aggregate required to make a unit of volume of concrete may readily be determined from the absolute volume given by the calculations already described.

(11) If the mixture is such that the voids in the aggregate are not fully filled by the mortar, the voids will not be the measure of the voids in the concrete; but if the voids in the concrete are known, the ratio of the cement to the voids in the concrete may still be an indication of the strength of the concrete, except in the more extreme cases.

(12) The amount of voids in a specified mixture of mortar may be used to determine the acceptability of a given fine aggregate, so far as size and gradation are concerned.

(13) The method may be used to design the mixture of the concrete whatever the amount of cement used and whatever the ratio of coarse aggregate to fine aggregate, provided the mortar fills the voids in the coarse aggregate.

In making a mortar test of a fine aggregate, the voids are determined for increasing amounts of mixing water. The amount of water that gives the minimum volume of the mortar (greatest density and least voids) may be termed the basic water content. The charactertistic mortar-voids curve made up from values of the voids for minimum volume of mortar may be termed the basic characteristic mortar-voids curve. The basic water content permits a very good consolidation of the particles of the mass when put into the mold; more water swells the mixture, as it also adds to the mobility. For other water contents, giving the wetter consistencies, such as for example 1.20 times the basic water content, characteristic mortar-voids curves may be made up from the voids data obtained with the specified water-content ratios in the tests already made. If a larger amount of water than the basic water content is to be used in the concrete, the charactertistic curve for that proportionate water content should be used in the calculation. For the consistencies generally used in concrete work, the water content will range from 1.10 to 1.40 times the basic water content, though even wetter mixtures are frequently used without regard to consequences.

That there is a relation between cement, voids and strength of mortars and concrete has been recognized for many years. Feret, the noted French engineer, in discussing his tests stated that for all series of plastic mortars made with the same cement and of inert sands, the compressive strength after the same time of hardening under identical conditions is solely a function of the ratio of the amount of cement to the space in the mortar outside of the sand particles, and varies with the square of this ratio, whatever be the nature and size of the sand and the proportion of the elements. Taylor and Thompson give a diagram showing Feret's results and formula. A recent contribution of Feret gives additional information on the mortar-making qualities of a variety of fine aggregates that confirms the earlier statement of the intimate relation of voids, cement and strength of mortars. Although the tests of Feret referred to are mainly on mortars, inferentially the same principles apply to concretes. Withey has plotted the data from Technological Paper No. 58 of the U. S. Bureau of Standards by Wig, Williams and Gates, to show the relation between strength of concrete and ratio of amount of cement to voids in concrete. Other writers have pointed out similar relations.

4. Density and Voids in Mortars and Concretes.—By means of the mortar-voids test to be described, the magnitude of the voids in a unit of volume of mortar may be found for a given proportion of cement and fine aggregate. The magnitude of the voids should be determined both for

an amount of mixing water which gives a minimum volume of mortar for the given mixture (an amount of water and a condition which herein is called the basic water content) and for one or more other water contents. When such data are available for a number of mixtures (proportions of cement and fine aggregate) the characteristic mortar-voids curve may be drawn. Fig. 1 represents such curves for a given sand, the lines representing basic water content (minimum volume) and a water content of 1.40 times the basic water content. For this sand with a mixture having twice as much sand as cement by absolute volumes, it will be seen that the voids in the mortar constitute 28.3 per cent of the volume of the mortar when the mixing water is such as to give minimum volume, and 37.5 per cent when 1.40 times this amount of mixing water is used. It will be shown that the characteristic mortar-voids curves for different fine aggregates vary widely, each material showing an individuality.

5. Analytical Relations. — If the voids properties of the mortar are known the application to the concrete mixture may be made by analytical considerations through the use of the equations which follow. The following notation will be used:

a = absolute volume of fine aggregate in a unit of volume of freshly placed concrete;
b = absolute volume of coarse aggregate in a unit of volume of freshly placed concrete;
c = absolute volume of cement in a unit of volume of freshly placed concrete;
d = density or solidity ratio of the freshly placed concrete;
v_m = voids (air and water) in a unit of volume of the mortar mixture of cement, fine aggregate and water as it exists in the concrete;
v = voids in a unit of volume of concrete. This, of course, will be equal to $1 - d$.

It is evident that

$$a + b + c = d = 1 - v \quad (1)$$

Since the mortar and the coarse aggregate together make up the unit of volume, it is also evident that

$$\frac{c + a}{1 - v_m} + b = 1 \quad (2)$$

A third equation derived from equations (1) and (2) will be found useful:

$$v = v_m(1 - b) \text{ or } b = 1 - \frac{v}{v_m} \quad (3)$$

With the charactertistic mortar-voids curve of a given fine aggregate known, it will be shown that the analysis may be made to apply to a variety of problems, such as to find the density and thereby the strength of the concrete with a given cement content and a given ratio of fine aggregate to cement; to find the density of the concrete and the amount of fine and coarse aggregate in a unit of volume of concrete when the amount of cement and the ratio of the coarse aggregate to the fine aggregate are given; to find the amount of cement required with different fine aggregates to produce a given density and strength; and to find the water content for a concrete when the water-content curve for the mortar is known. The applicability of the characteristic mortar-voids curve to these problems and the use of the analysis in the design of concrete mixtures are illustrated in the latter part of the bulletin.

It may be helpful to a quicker comprehension of the significance of the equations to know something of the range of values of the variables. For mortars of medium richness at about normal consistency v_m ranges from 0.27 when made with a coarse, well-graded sand to 0.40 with a very fine sand. For concretes the density d may range from 0.70 to 0.90. The ratio $\frac{a}{c}$ is somewhat greater than the ratio of sand to cement by loose volumes; it ranges from 1 for very rich mixtures to 5 for very lean ones. The absolute volume of the cement c ranges from 0.05 for a very lean concrete mixture to 0.15 for a rich one. The absolute volume of the coarse aggregate b will be 0 in a mortar and 0.5 or more in a coarse mixture. For a 1:2:4 mixture of fairly good materials, the values may be as follows: $c = 0.10$; $a = 0.28$; $b = 0.45$, these being the volumes of the solids in a unit of volume of concrete (cubic foot, cubic yard, etc.). For this example, it will be seen that $d = 0.83$.

Conclusion

Comments.—The combination of the mortar-voids tests, the analytical relations of cement, aggregates, voids and water, and the experimental determination of strengths, by the methods outlined in this bulletin, offers a useful method for the study of materials, the design of concretes, the calculation of quantities, the comparison of mixtures, and the estimation of strength.

The mortar-voids test takes account of the factors which give uncertainty to the sieve-analysis function. If the requirements for structural strength and surface adhesibility be otherwise guarded, it will enable new or untried materials to be judged. It will permit easy comparison of aggregates. It is of interest in showing what range of mortar richness will produce the best results with a given fine aggregate and thus in aiding to find conditions under which the use of what may have been thought to be a poor aggregate can be permitted.

The design and estimation of strength of mixtures may be made for a given amount of cement, for a given limit of quantity of coarse aggregate or any smaller value, or for a given ratio of cement and sand. A reduction curve may be obtained for finding the relative strengths for different relative water contents, based on the basic water content, that giving the minimum volume of the mortar and concrete.

The use of the absolute volume of the materials give simple and convenient methods of analysis and calculation, and in many ways is advantageous. To think in terms of the absolute volume of the materials in a unit of volume of mortar or concrete itself gives an advantage in making comparisons and judging effects. When the density of the material as it is found by the method of measurement to be used on the work is known, the volumes by bulk measurement may easily be obtained. The advantage of measuring aggregates by weight, in producing concrete of uniform quality, is apparent. Since the specific gravity of sands in a given locality varies but little, the use of an average specific gravity is sufficiently accurate for most purposes.

The method of treatment brings out the old principle that other things being similar the strength of the concrete is equal to the strength of the mortar of the concrete. "Other things" refers to the water content, to the degree of compactness, to the conditions of storage, etc. Limitations in such matters as amount of coarse aggregate may be expected to come within ordinary practice in well-made concrete.

It should be noted again that the equation for strength of concrete in terms of the voids-cement ratio or cement-space ratio will be dependent upon the quality of the cement, and that some variation in the constants of the equations may be expected. The tests were made at an age of 28 days, but equations of the same general form for strength at other ages may be determined from experimental data.

The matter of allowance for the water absorbed by the coarse aggregate during the period of placing and setting will need careful attention in so far as this affects the amount of water left to be counted as mixing water. Any water carried into the mixture on the surface of the particles of the coarse aggregate and not absorbed by the aggregate during the period of mixing and placing will, by the technique described for the tests, be included in the amount considered as mixing water.

Further study and experience will doubtless develop limitations and suggest modifications and standardization of methods. To what extent and in what way account should be taken of the possibility that the sum of the volume of the mortar and the coarse aggregate may not reach unity, is one question. What limit to the volume of the coarse aggregate may best be used for different aggregates, different water contents and different kinds of construction, may well be studied. The shrinkage of wet mixtures and rich mixtures needs consideration. The effect of air voids upon the strength of concrete, and also the effect of the absorption of water by the aggregates during and after the setting of the cement, should be studied. The effect upon strength of the addition of water beyond basic water content for a variety of fine aggregates is worthy of experimentation and study, as well as methods of

allowing for the reduction in strength accompanying an increase in water content. These and other topics deserve to be taken up by a number of research laboratories and given careful study, regardless of whether the methods outlined in this bulletin are considered the most satisfactory for the study of the designing, comparison and determination of quantities for concretes.

Resume of Methods.—In review of the steps to be taken in the application of the methods outlined in this bulletin, the following is presented:

(1) The mortar-voids curve is determined experimentally. For certain purposes the use of a general mortar-voids curve of materials having the same characteristics may be sufficiently accurate. Mortar-voids curves may well be made up for two or more water contents.

(2) Curves giving the water content, cement content and ratio of voids to cement for varying ratios of fine aggregate to cement may be made up from the data of the mortar-voids test.

(3) An equation or a diagram giving the relation between the strength of mortar and concrete at a given age for the common run of cements should be available, as should a reduction curve for the effect of relative water content.

(4) The limiting value should be known or judged for the absolute volume of the coarse aggregate that may be used under the conditions of placing and tamping obtaining on the work.

(5) For use in making measurements by bulk, the density of the fine aggregate and the coarse aggregate for the method of measurement to be used on the work should be known.

(6) With such information the use of the analytical relations given by the equations will permit designs, comparisons and estimates of strength and quantities of materials to be made.

It is felt that the method of attack outlined in this bulletin will be helpful in the work of analyzing, comprehending and judging the effects of the various elements entering into the strength properties of concrete, as well as in many applications to the problems of practice.

Brick Laying Machine.—A mechanical brick layer capable of laying 1,200 to 1,500 bricks per hour has been invented by a Scotchman, according to The Nation's Business. "With a mortar tank, a hopper of brick, and a motor the new machine is said to lay its course of brick, come back, break joints, and even skip the openings. The thing 'taps' each brick to settle it in the mortar."

Business Conditions as Seen by the National Bank of Commerce of New York

The following is from the "Money and Markets" circular of the National Bank of Commerce for Nov. 17:

Opinions differ as to the real state of trade. Some people point to the many industries which are operating at relatively low rates of capacity. Some call attention to the continued lack of forward orders. Business is undoubtedly spotty both in lines of industry and in sections of the country affected by special agricultural conditions. From these facts and the increasing demands of labor the conclusion is drawn that business cannot be good.

Admitting the facts, do they mean that we are to have worse rather than better business? The answer would seem largely to be found in the state of retail trade. Retail trade is undoubtedly good in useful articles and not so good in articles which can be done without. That retail business as a whole is satisfactory is confirmed in the experience of distributors who without exception report no abatement in the steady flow of small orders rather than seasonal purchases as in former years.

Stocks of goods are reported as not large either in the hands of the producer, distributor or consumer. It is true that facts as to stocks are difficult to get but there are always more or less unerring indications which enable experienced business men to discover whether they are excessive. Thus in 1920, although direct evidence as to accumulations of goods was lacking there were sure signs of the existence of heavy stocks. Delays in transportation concealed a large volume of goods, credit expansion was extreme and money was high.

Today these signs are absent. Expeditious transportation gives assurance that heavy stocks are not out of sight on the railroads. Commercial loans are not excessive and are fluctuating through a narrow range and easy conditions prevail in the money market. With active retail trade, reasonable stocks of goods and factory operations at low levels in many important lines, the opinion is justified that continued consumption based on full employment of labor must bring about increased rather than reduced industrial activity.

Waterproofing a 525x75 Ft. Roof Terrace

Methods Employed at the U. S. Naval Academy, Annapolis, Md., Described in Public Works of the Navy

By LIEUT. ROBERT R. YATES

A noteworthy example of the difficulties which a waterproofing project can assume has lately been encountered at the Naval Academy in dealing with the leaking roof area over the mess hall. The problem in this instance is further complicated by the necessity of using the roof as a terrace for drill formations, which in turn requires an almost flat surface, the prevailing slope from center line to each side being ¼ in. per foot.

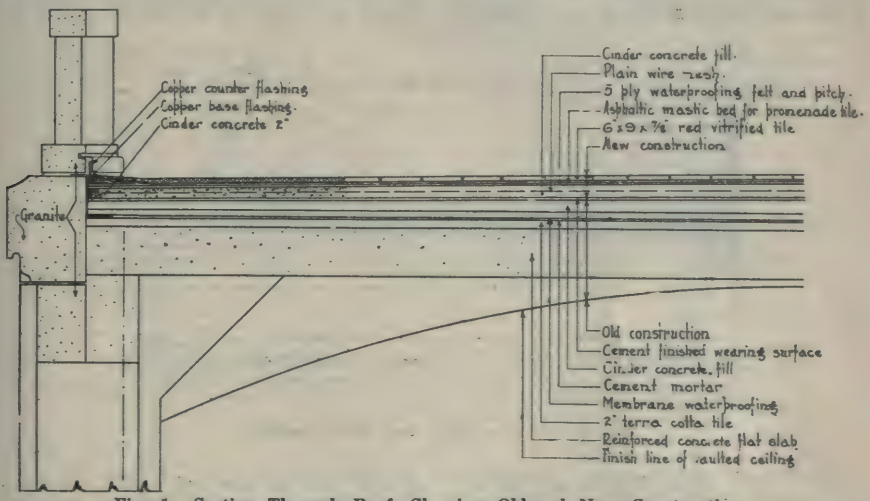


Fig. 1. Section Through Roof, Showing Old and New Construction.

Construction Details of Old Roof.—At the outbreak of the World War the Naval Academy had entirely outlived the capacity of its buildings, and as part of expansions undertaken at that time it became necessary to enlarge the mess hall to overall dimensions of approximately 525x75 ft. A new roof was provided in its entirety, consisting of flat slab construction, over which was placed a layer of 2 in. terra cotta tile, with a superimposed 1 in. mortar bed. The tile was considered necessary in order to prevent the outside surface heat being carried to the slab. The waterproofing blanket, of cotton fabric and an approved compound, was laid directly on the mortar bed. Next followed, in order, a cement mortar protective coat, a cinder concrete fill, and a cement wearing surface.

The contract stipulated that the waterproofing blanket be turned up along the walls into raglets, and it was afterwards decided to use copper flashing and counter-flashing as protection for the upturned edges.

The contract further provided for a 5-year guaranty of the waterproofing, and under these terms the contractors were privileged to make such changes as would not nullify the guaranty. Among the changes made was the use of copper flashing without turning up the waterproofing blanket along the side parapet, reliance being placed entirely upon the adhesion between copper and fabric to maintain the roof in a watertight condition.

Why the Old Roof Leaked.—Shortly after the roof was completed serious leaks began, which were not confined to any particular portion of the roof but were widespread. From the scheme of construction previously noted, it can be seen that should the

water penetrate through the various surfaces and the waterproofing down to the tile it would flow rapidly through the latter and possibly seep through the ceiling at a considerable distance from its point of entry through the waterproofing.

Upon investigation it was found that the leaks were due to several causes, chief of which was the lack of bond between the copper and the waterproofing fabric, permitting the water to get under the latter. Also, there were places found in which the waterproofing was quite thin, and still others where the blanket had been torn, through poor workmanship. Unfortunately, the major part of the work was performed by a sub-contractor, and the general contractor was unable to force him to proceed with the remedying of the work. The general contractor, in turn, refused to proceed with the righting of the defects unless paid therefor, the contract having been let on a cost plus percentage basis; and it finally became necessary for the Government to declare the existing contract null and void and to proceed with remedying the unsatisfactory condition as a separate project.

After further investigation and discussion it was concluded that the leaks were so numerous that the whole roof should be resurfaced and rewaterproofed, and a contract for the work was let to another firm, at approximately $58,000.

The New Construction.—The new construction proceeded as follows:

First, there was placed over the old surface a layer of cinder concrete held together by wire mesh and floated to a smooth mortared surface. This surface was mopped with an asphalt primer and then treated with a coat of asphalt pitch, in which was embedded a layer of asphalt felt weighing approximately 14 lbs. per square. Next followed alternating layers of pitch and felt, until five of each had been applied, this thickness being obtained by lapping each ply of felt for four-fifths of its width over the preceding one. Along the sides and ends the waterproofing was turned up and protected with copper flashing and counterflashing. The wearing surface consisted of red vitrified promenade tile 6 by 9 by ⅞ in. embedded in a

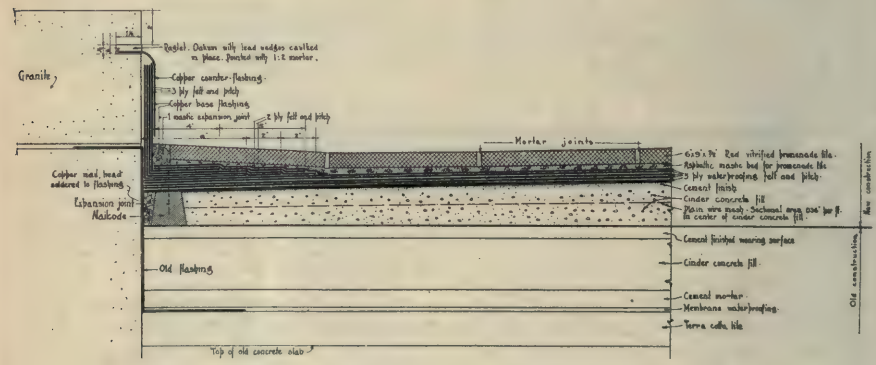


Fig. 2. Detail of Roof and Wall Flashing.

$\frac{3}{16}$-inch mastic coating which was applied directly on top of the waterproofing. The joints between tiles were made ⅜ in. wide, and were filled with mortar composed of equal parts of Portland cement and sand. Figs. 1 and 2 clearly indicate the details of the resurfacing and flashing as placed. Fig. 3 shows a typical catch basin (half section).

Expansion joints in the cinder concrete, approximately 50 ft. apart, were made to come directly over those of the existing roof. They were formed with ¾ in. "Elastite" strips to the full depth of the cinder concrete. The waterproofing felt was carried directly over these expansion joints, the manufacturers of the felt giving assurance that the material was capable of stretching or compression within the limits defined. Two series of expansion joints were provided for the

tile, filled with a special asphaltic material as prepared by the waterproofing contractor. One set came directly over the joints in the cinder concrete. The others, ¾ in. wide, ran perpendicular and parallel to the latter, dividing the surface into 25-ft. squares.

Shortly after completion of the work a few leaks developed in the under side of the roof, which were due to rain water collected in the cinder concrete before the application of the waterproofing surface. Holes were drilled from below, and in this way within two months all of the water had been drained. The roof was thoroughly tested by stopping the drains and flooding to the height of the handrail base. The water was allowed to stand for 48 hours, and the waterproofing did not show the slightest defect.

For the past two and a half years the roof has proved absolutely watertight, thus removing a long-standing source of complaint of midshipmen and officers attached to the academy. The same method of waterproofing has since been used on the terrace and the deviascope platform of the new seamanship and navigation building, and to date has not developed the slightest flaw.

Method of Cutting Raglets in Granite.—One of the distinct novelties in the construction was the method of cutting raglets in the granite to receive the copper flashing. There were about 2,500 lin. ft. of raglet to be cut, and the contractors, after trial, decided that handwork was too slow and expensive, the cost exceeding $3 per linear foot. It was then decided to try a new method, namely, cutting the raglets with a sand-blast machine; and, accordingly, two such machines were purchased. Along the surface of the granite base a special cushioning compound was spread for a width of 6 in., the exact width of raglet being left exposed along the center line of the applied material. Each machine was capable of cutting approximately 30 lin. ft. per 8-hour day. To obtain satisfactory results the air pressure for such blasting must be at least 80 to 90 lb., and the volume of discharge great. The latter effect can be secured by using a fairly large supply pipe, acting more or less as a receiver. In this particular case 2-in.

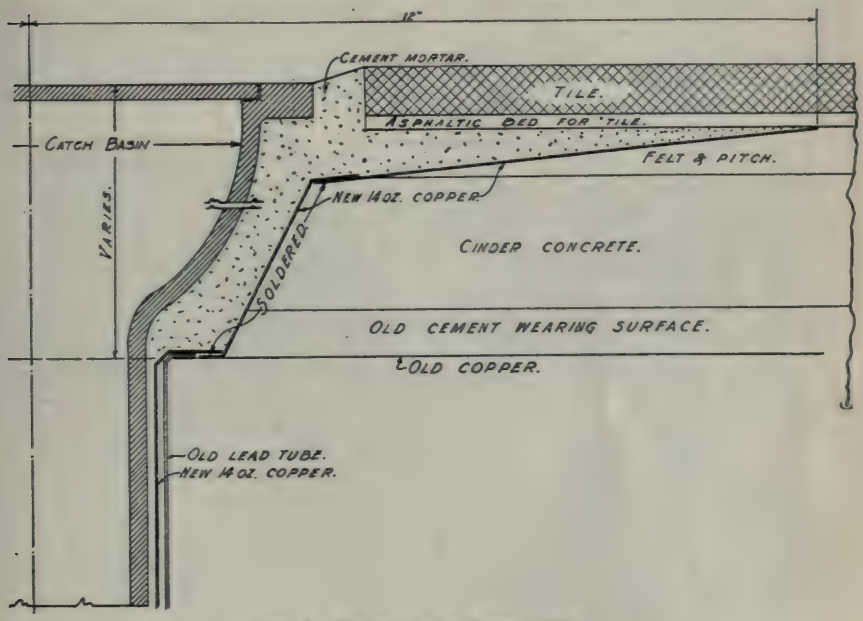


Fig. 3. Typical Catch Basin Details.

and 1½-in. pipes with 1-in. hose connections were used.

The two machines cost $500 each, and the total labor cost, including pipe fitting operations on air compressor, boiler, and machines, was $4,539.62, or $1.81 per linear foot (375 lb. at 65 ct.), or 9.5 ct. per foot. Approximately 70 cu. yd. of sand were required. Operations were begun with the use of Ottawa white sand, but this was found to be of no great advantage over the local product. The sand lost its usefulness by mechanical action after two or three blasts through the machine.

The sand-blasting method proved to be a distinct advantage on this particular work, where time was a factor and where the distance of raglet from the edge of granite base was so small that hand cutting would have necessitated great care to prevent chipping. Furthermore, the process proved more economical than handwork, even counting the price paid by contractors for the machines, which suffered practically no deterioration on this contract. The cutting by sand blast might have been made even more economical, as any intelligent laborer can be very easily taught the work, but in this instance it became necessary to use highly paid union stonecutters, who apparently did not wish to make an impressive showing with the sand blast.

The contractors declared themselves well pleased with the results obtained from the sand-blast machine, and expressed the opinion that its use would be a distinct advantage where there is any large amount of raglet to be cut.

The government refused to accept the first waterproofing described in this article, but under the terms of the contract was obliged to permit the contractors to make detail charges which they claimed would not nullify their guaranty, and which they insisted upon as part of their waterproofing system. It was found that the government's interest had been safeguarded in every respect, and the second contract proceeded with the expectation that payment would be made under the bonded guaranty of the contractors for the first waterproofing; and the matter did, in fact, so eventuate.

Fig. 4. Laying Promenade Tile on Pitch-Felt-Mastic Waterproofing Blanket.

How the Architect Can Secure Publicity

Some of the Important Elements in a Publicity Plan Outlined in The Architectural Forum

By HOWELL TAYLOR

In selling his service to the client, the successful architect must study the client's point of view. He must anticipate a client's demands and be able to present convincing proof of the value of architectural service. Let us examine the mental process of an average prospective client. We may safely assume that he is a business man. His impulse to build is set in motion by commercial needs or the desire to improve some condition. He asks himself what kind of building he wants. He thinks in terms of what he has seen, of what he is reading, and of what his associates tell him. He reads two or three trade magazines relative to his business, one or two class magazines and perhaps one general magazine; he will glance through a striking monograph sent to him through the mail; personal letters addressed to him will usually receive answers, and he will generally accept personal calls relating to anything in which he is really interested.

Gaining the Prospective Client's Attention.—The details of large building operations come into the experience of the average prospect but seldom—once or twice in a lifetime perhaps. When his building problem does present itself, the degree of its importance is considerably exaggerated. He has always supposed that he knew a lot about so simple a thing as building, but he finds he is confronted by something very complex. He knows in a general sort of way that architects plan buildings. He has heard that some are good and others bad. He knows that there are building corporations which keep within cost estimates and take complete charge of details. He discovers that he must investigate the situation very carefully, but finds that he first wants to know what has been done in the field which interests him. Here then is offered an excellent point of contact for the architect, and it is up to him to make the most of it. The client's attention can be gained not by explaining what good architects they are, but by presenting very graphic descriptions of buildings which interest him in media that he cannot help but see, making careful mention of certain important solutions and the architect's connection with them.

Were the public generally "sold" on the idea of hiring an architect for its building operations, as it is on the idea of engaging a lawyer to fight its legal battles, perhaps no concessions to the modern business point of view would be necessary on the part of the architect; but it is not, and the problem resolves itself then into one of expediency. It is not a question of "Shall we advertise?" but "How shall we advertise?" How shall we educate our potential clients to the point of buying our service?—for when a definite point of contact is determined, it becomes a simple matter to present the worth-while facts concerning an architectural office which will prove to the client the reasons why he should select this or that practitioner.

Some means must be found of catching a client's interest, but no architect's service will do this unless he has actually arrived at a point where he is ready to select his architect. More often than not the process of his education regarding the building he wants has been so closely associated with his observations about architects that his mind (on selection) is made up before he realizes it. Often, however, the old story about the early bird holds good; in other words, the architect who goes after the business in terms that a client expects to hear, commenting here and there on the way his office would handle certain problems, will find that he is selling his services.

The "Service to You" Idea.—A client's first impulse, when his building problem presents itself, is to set in motion some sort of investigation which will give him a fairly complete idea of what has been done in the field where his interest lies and what is the general trend in similar buildings under construction. The alert architect must sense this impulse and

be prepared to meet it in a way that the client understands. For example, glance through the advertising pages of any newspaper or magazine and you will find that except in the case of well-established houses which are now doing "institutional" advertising, every commodity is presented with a "service to you" idea. It must be clearly held in mind that the average client cares little who his architect is if he gets what he wants.

In the automobile field the day has come when the name of a car is sufficient guarantee of its quality. In a measure and among a few broad gauged people the same is true in architecture, but the rank and file of the average prospective clients do not know one architect from another except in a very general way. In fact among a large majority of people the word "architect" means an expensive luxury that must be avoided by practical people. To become so well known that the mention of the name suggests the quality and nature of a service is most desirable, of course, but is only possible through years of carefully planned publicity. Word of mouth advertising is the best sort always, but its scope is very limited, and it seldom builds up a broad field of activity.

The architect must meet his selling problem at an earlier stage in the mental process of his client than he has been doing, and the means of accomplishing this deserves the most careful study. The first step in determining a logical plan of publicity is a survey of the fields of building construction that are being covered. The question must be asked, "Just who are my clients?" and "Why am I equipped to handle their building problems?" A consideration of the training and personal equipment of an architect's office will often reveal a broader field of activity than is at first realized. For instance, hotels, hospitals, apartment houses and institutional housing projects are closely allied architectural problems although widely different types of building from the users' points of view, and prospective clients should be sought by wholly different methods.

The Value of Descriptive Articles.—The next step is the determination of the most natural means of directing the attention of the prospective client to the architect's service without forcing him to a consideration of selecting an architect before he is ready to do so. At this time the news columns of trade magazines offer the best means of general publicity for the architect. Trade and class magazine editors will be glad to receive well written material on many subjects of interest to their readers. Many of the buildings which an architect constructs can be made the basis of descriptive articles and interviews which should be published over as long a period as possible. Such articles should always contain items of human interest, statements by owners, etc. A careful study of the trade and class magazines will determine the type of material each most readily prints. Another good source of publicity lies in the intelligent use of newspaper reports. When an important project is being launched or a building started or completed, careful reports should be prepared in the architect's office. Newspaper reporting has become such a standardized process, and newspapers are so accustomed to receiving usable material from the scores of press bureaus maintained by as many organizations, that often the less important projects go unnoticed if the story has to be sought out laboriously by staff reporters.

How to Get Articles in the Newspapers.—Architects should study news writing and prepare brief descriptions of new buildings, incorporating items of general interest whenever possible. If identical copies are sent with good photographs to all newspapers within a radius of 200 miles of the buildings, it is likely that a majority of the papers will publish them. They should be marked for release on a certain date several days in advance of the mailing to insure simultaneous appearance if the papers' editors desire. If 12-em (one-column) or 24-em (two-column) electrotyped cuts or mats of 65-line screen can be sent instead of photographs, publication will be more certain.

All such articles should be reprinted in quantities and mailed to prospective clients whenever they provide matter of direct interest to someone. These should always be accompanied by a brief but well written letter calling attention to a specific point of the

architect's service which applies particularly to the proposed new work.

Under a well-conceived plan of publicity, carefully prepared loose-leaf monographs are of great value, for they can be kept up to date and used in giving clients a comprehensive survey of the fields in which they are interested. These monographs should include the work of other architects, and should give the prospective client as broad and unbiased a concept of the general type of building he proposes to construct as can be had. If the architect has kept in touch with the industrial development of the community in which he is practicing, he should be able to anticipate the needs of a large majority of the industrial and philanthropical institutions, and be able to use these monographs in establishing a contact with prospective clients whom he believes are in the market for additional building.

The most should be made of executed commissions in the smaller communities. No member of any board or building committee with which an architect has had a connection should be allowed to forget the fact that a certain architect performed a certain work. They are often members of others boards, and are generally prominent business men. The full scope of the architect's practice should be brought to their attention.

Small Jobs as Leaders for Big Ones.—Encourage the men of the staff to bring in new work. Do not forget that every man, however humble may be his part in the organization, may have connections through which publicity can be obtained and lead to valuable commissions. Besides, keeping the man's interest in the office will introduce new clients to its service. Some of the work from this source may be small, and for larger offices will just about pay for the cost of producing drawings, but a new client is always an asset, and if the architect builds a $10,000 house successfully, the client is likely to come back with a $500,000 factory some day, or school building or church or hospital. Architects now make a practice of doing the minor work of clients who have come to them for important commissions. Why not reverse the process? Take the small jobs first, and trust that the client will become influential in other large building projects later.

In all these suggestions the attempt has been made to include but a few of the important elements which an architect may use in laying out his plan of publicity. There is no set rule. Each office will have to determine for itself what specific items will best promote its growth and keep its name before the larger number of potential clients. One thing is important to consider—no plan of publicity, however carefully it is laid out, is apt to bring immediate results. If an architect expects that his advertising and selling effort, which is established as a new and aggressive policy, will bring him tangible results within a few months, he will be disappointed, for his efforts will probably go unrewarded for a year or more. Such a condition should not discourage the use of a logical plan, however, for it has been the experience of many other concerns that are now firm believers in advertising.

"What does the advertising dollar buy?" It buys insurance for the future of the user's business. It buys the necessity of careful codification of the purposes and policies of the firm. It buys the respect of the modern business world, if done honestly, as well as the respect of every member of the firm's staff. Many users have found advertising to be the panacea for all the ills of organization and selling. It is not unreasonable to believe that a more general use of carefully planned publicity by architects will produce similar results.

Long Column Timber Tests.—Tests are under way at the Forest Products Laboratory, Madison, Wis., on 12 by 12 in. by 24 ft. southern yellow pine and Douglas fir timbers. The tests, which are being made in co-operation with the National Lumber Manufacturers' Association, are for the purpose of studying column formulas and laws, to obtain data on the effect of density and defects, such as knots and shakes in columns, and with these data as a basis to recommend safe working stresses for structural columns. The testing program as outlined covers a 4-year period and will include tests on both green and air-dried material, ranging in quality from clear and dense to very defective and light-weight material.

English Tests of Heat Transmission Through Walls

Report of British Research Board Summarized in Engineering, London

The rate at which walls, floors, ceilings and their coverings transmit heat does not depend only on what is known as their true conductivity, that is to say, the rate of transmission under unit difference of temperature between their faces. In practice it is also affected by unsteady variations of the temperature difference (such, for instance, as may occur if one face is suddenly but not steadily heated), by heat lost by conduction through edges, by radiation, and by convection. These factors are eminently difficult to standardize, and for the purpose of comparing different materials accurate determinations of the true conductivity may be of considerable practical value. The Building Research Board has accordingly published a report* on experiments on the subject made for them at the National Physical Laboratory by Dr. Ezer Griffiths, with an introduction by Mr. H. O. Weller, director of building research. These experiments deal with the true conductivity, measured under a steady flow of heat, and in appendixes an account is given of work done in Norway, Sweden and Germany, in which results are given for measurements of transmission of heat through all causes.

The results are given alternatively as the heat in British or C. G. S. units which flows through unit area and thickness of the material in unit time under a steady temperature difference of 1° F. or C.; in the case of composite walls the figure is given for the entire thickness. Taking British units for convenience, it is to be remembered that the conductivity of still air is 0.14 B. Th. U. per square foot per hour for 1 in. thickness and 1° F. temperature difference. So far as materials are known at present, this is the asymptotic limit of their lowest conductivity.

The Material Having Lowest Conductivity.—At the very end of some experiments that Dr. Griffiths made for the Food Board in 1921, he got hold of a little piece of cellular expanded rubber vulcanized under a gaseous pressure of 100 atmospheres, so as to produce an extremely large number of very minute pores bounded by very thin walls, and, as far as could be determined by such experiment as was possible on the sample, this had a conductivity only half as large again as that of still air, as against about double the conductivity of still air for a number of fine porous powders and fibres (cork, slagwool, charcoal and wool fibre). Hereabouts lies the lowest conductivity of any materials at present known, and this ceases to be maintained or even approached when the material is damp. As a very rough figure for comparison with the present results it may be called 0.3 B. Th. U.

Conductivities of Various Materials.—Dr. Griffiths' present figures show that with two exceptions the materials of building construction have conductivities of quite different orders of magnitude. The lowest of those he examined are diatomaceous bricks, which have a conductivity of rather over twice to three times that of the porous powders, and a flooring material prepared on Dr. Schryver's process from exhausted castor beans also had a conductivity of about three times that figure. The next lowest is a chalk-cement (20:1) concrete, used for the walling of one of the experimental cottages erected by the Board at Amesbury, with a conductivity of 2.2, about seven times that of the powders. Ground brick and lime followed with a conductivity of 2.9, sand-lime (2:1) 3.3, sand-cement (4:1) 3.7, and so on among concretes and plasters up to York stone-sand-cement (4:2:1) 7; showing over all a conductivity in concretes and plasters varying from about 7 times that of the powders to something over 20 times. The usual walling materials have conductivities beginning in the higher range of the concretes. Thus Fletton bricks in cement-mortar are 4.4 and in lime-mortar 5, London stocks 6.1, pisé of clinkers and lime 8.1, and of clay and gravel 8.7, and sand-lime bricks in cement-mortar 9.3; say from about 14 to 30 times the conductivity of the powders. Both better and worse results were obtained from the cavity and composite walls. These re-

*"Heat Transmission Through Walls, Concretes and Plasters": H. M. Stationery Office, London. Price 30 ct.

sults were, of course, not per inch, but for the total thickness, and cannot therefore be compared summarily with the figures just given. The best was 9.6 for a 6-in. timber frame construction, made of 1-in. rough boarding with 4-in. by 2-in. studding and lath and plaster, and ¾-in. weather-boarding, roughly about a third of the conductivity of the same thickness of London stock bricks in cement mortar; next came a wall of 12-in. by 9-in. by 6-in. hollow terra cotta bricks, with a conductivity of 19.7. In most cases the sample wall or slab was made several weeks before test and allowed to dry out thoroughly. The extent, however, to which moisture would have affected the results was illustrated by testing a well of 9-in. stocks fixed quite wet during June; what year or what temperature and conditions of atmospheric moisture are not stated. The initial conductivity was 15.8, which dropped in a week to 9.67 and took a further week to reach its normal 6.1. This indicates that in exposed conditions many porous materials would be worse than useless as insulators, though they might be serviceable as internal linings.

Application of Results of Tests.—In his introduction to the report Mr. Weller draws attention to some practical consequences from its results. To indicate the effect of insulation on the domestic economy he compares the conductivities of sand-lime in cement and Flettons in lime, and calculates that the difference in conductivity shown from the above figures —about 10.7—amounts in a heating season of 170 days to a loss of heat that would take something over a ton of coal to make good, in the absence of which the house would be correspondingly "colder." This is apparently on the assumption of central heating with a 60 per cent efficiency, and perhaps understates the effect in British conditions. Other results show that the insulation can be improved by building the walls with cavities. The framed timber wall, which gave the best results, is open to the objection that its insulating power is reduced greatly by leakage when the outer skin is split or broken, apart from other obvious disadvantages. Something approaching its insulating efficiency can, however, be got by building hollow brick walls. Thus a hollow 11-in. wall of London stocks would have a conductivity of little over 11, as against the 9.6 for the 6-in. framed timber wall. The whole of the figures are however affected by the process of manufacture; cement-concrete, for instance, becomes more conductive as it becomes denser and richer, and according to the Norwegian results light-burned bricks are less conductive than hard burned. It is stated accordingly that in these experiments care was taken to see that the experimental samples represented fair average practice in good work. The figures for pisé (rammed earth) indicate that it is more conductive than bricks for equal thickness, and owes its reputation for insulating power to the greater thickness in which it is used. Perhaps the most striking figure for practical purposes is that of the chalk-cement concrete, quoted above, of which the insulating power is roughly three times as great as that of London stocks in cement.

How the Tests Were Made.—Two methods of test were used according to the order of magnitude of the conductivity in question, each of these depending on measuring the heat flowing normally to the surface through the thickness of the sample. In each method the source of heat was an electrical hot plate, consisting of a coil or mat of nichrome tape so wound as to communicate heat uniformly all over the surface, and insulated with thin sheets of micanite. For materials of high conductivity, such as walling, in which the heat flowing through the surface was large relatively to that which escaped from the edges and corners and had to be allowed for by a calculated correction, the sample of about 9 sq. ft. area was backed by the hot plate, and this again by a 6 in. slab of cork extending over and beyond the hot plate, the edges of the sample and hot plate being embedded in granulated cork held in a framework. By a number of copper-constantan thermocouples the temperatures of the hot and cold faces of the slab and of the wall under test were taken, and from the electrical energy used in the hot plate and the temperature readings the total heat, loss through edges and corners, and conductivity of wall were calculated. With hollow samples duplicate tests were made in horizontal and vertical positions, disclosing differences of conductivity due to convection currents ranging from about 2½ per cent

to 10 per cent. Materials of higher conductivity were tested in duplicate slabs, each about 2 in. thick and 12 in. by 12 in. area. These slabs were provided with metal faces and sandwiched about the hot plate, which in this arrangement was surrounded by a "guard-ring" of the same construction and in the same plane as itself. and from a separate supply of current maintained at the same temperature, so that no flow of heat took place from the edges and corners of the hot plate.

A brine circulation in pipes was provided against the outer metal plates fixed to the samples, so as to treat them as cold faces and maintain them at a constant low temperature, and the whole was embedded in granulated cork. From the electrical energy and the temperatures of the hot and cold faces of the slabs, taken with thermocouples at various points, the conductivity was calculated. The readings reckoned in the test were not begun till a steady flow of heat had been established, which might take some days.

Covering Capacity of Whitewash or Cold Water Paint

The following figures from a recent bulletin of the National Lime Association will be of assistance in estimating the amount of materials required and the time needed to cover wood, brick or plaster surfaces. It is, of course, to be understood that these figures are only approximate since there are many factors, such as condition of the mortar joints in brick work, roughness of lumber, and previous treatments which will have a very decided influence on the covering capacity of the wash or paint.

Whitewash or cold water paint will weigh, on an average, about 12 lb. to the gallon. A gallon will have the following covering capacity:

On wood, about 225 sq. ft. (10 ft. by 22½ ft.).

On brick, about 180 sq. ft. (10 ft. by 18 ft.).

On plaster, about 270 sq. ft. (about 8 ft. by 33 ft.).

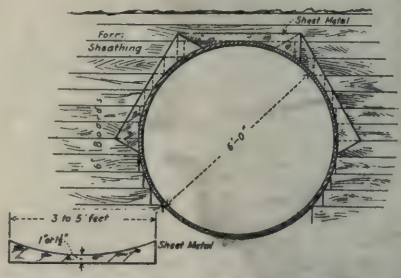
According to A. S. Jennings, a man with a 4-in. brush should cover the following surfaces per hour:

On rough walls, 22 sq. yd.
On smooth walls, 38 sq. yd.
On flat surfaces, 40 sq. yd.

A Formwork Kink

A useful method of fitting formwork around two steel water supply tanks was developed by H. W. Eldridge, engineer and contractor, on one of his jobs. The method is described in Contractor's Atlas.

The two tanks were each 30 ft. long and 6 ft. in diameter, supported at each end by concrete walls. In order to make a neat job of the formwork so that the concrete would have a good appearance, it would have been necessary to spend considerable time cutting and fitting the boards to the circle of the tank—in fact, to do a very good job would have meant cutting the ends on a band saw. To do away with the fitting operation, sheet



Sketch Showing How Forms Were Fitted to Circle.

iron plates cut to the proper radius were used to make a tight fit around the tank. These pieces each forming part of the required circle were cut from scrap pieces of black iron of about 18 gauge by the local sheet metal worker.

The form boards were cut with square ends, nailed to the studs in such a manner that the space between the square end of the form board and the outside of the tank was not over 2 in. The sheet iron pieces were tacked to the inside of the form. The sheet iron pieces were of varying lengths, depending on the scrap available.

The only fixed dimension in the piece of sheet metal is the proper radius and the provision of at least 2 in. at the narrowest portion. This method resulted in a saving of $4 per cubic yard of completed concrete on this portion of the work.

Contractors' Associations' Activities in Accident Reduction

Safety Work of General Builders' Association of Detroit, Mich., Described in Paper Presented Oct. 3 at 12th Annual Safety Congress of National Safety Council

By RALPH A. MacMULLAN,
Secretary, General Builders' Association of Detroit, Mich.

The General Builders' Association of Detroit is composed of seventeen members who have become so completely and permanently sold on the subject of accident, safety and prevention that they are imbued with the common interest of working together in complete co-operation. The Association has a safety committee composed of one man from each member firm, the secretary of the association, the insurance representative, and the chief inspector. This committee holds periodical meetings, both regular and special, for discussion of all matters that have to do with safety. The scope of its deliberation is broad enough to include amendments to the compensation law, important decisions on the subject of public liability. owners' and contractors' contingent liability, the subject of equipment, materials, and methods of handling them, and the like. It was this committee that actively prepared, approved and adopted the safety code of the General Builders' Association of Detroit, which has been used as a creed by our members and with which many of you are familiar because it has been republished and distributed rather generally throughout the United States and Canada.

To promote familiarity with our safety code and its intelligent application to safety problems on the jobs, our association appropriates, each year, a sum of money to be expended in bi-monthly installments as prizes for the best answers to questionnaires embracing ten questions that are distributed among superintendents, foremen and others on the jobs. These prizes range from $15 down to $1, with additional prizes given for helpful suggestions whether they apply to the code or not.

Keep Abreast of Latest Methods.—The result of this questionnaire has been exceedingly gratifying and indicates that men on the job are very much interested in helping their own situation, to say nothing of the helpful propaganda of convincing the employes that their employers are actively interested in them as evidenced by the attempt to save life and limb and preserve the men to their jobs. We cannot afford to overlook any possibility of betterment of our safety work by suggestions from the men actually on the job, and, further, the very thought given by the men to suggestions gives them what might be termed a "safety consciousness," whether their particular suggestion is of value or not.

The program of our safety committee is one of constant change to keep abreast of the best and latest practices and methods, and particularly designed so that the subject shall become commonplace or stale, and naturally is too extensive to permit of detailed reference here. One of the first and best details of that program, however, is the practice at times of holding periodical first aid classes showing practical methods of caring for accident cases and the education of one of the foremen or superintendent on each job in first aid work as well as that feature, perhaps more important, of impressing the conviction that an accident is a mighty good thing to prevent before it happens, and how to minimize the result of it when it does occur.

The Welfare Department.—As a valuable adjunct to the work of the safety committee is our welfare department wherein a trained nurse visits the home of each workman, whose injury requires hospital attendance. This nurse prepares a form provided for the purpose in which is noted information relative to the size of the family and general information about home conditions. If need of special financial or other help is indicated by the information gathered, we proceed from that point according to the merits of the case. Thus, a woman is given the task of breaking

the news of the accident to the family of the injured workman, as only a woman can do. Next, the nurse visits the hospital and informs the patient that she has been to his home and has rendered such comfort and aid as has been necessary, and gives the patient such assurances that he is relieved from worry about his family and home.

In case of an accident of more than ordinary gravity on any job, whether it be attended by severe results or results only potentially severe, the association convenes a board of inquiry consisting of the secretary, insurance representative, the chief inspector and the safety committee man in the employ of the member firm on whose job the accident occurred. As soon as practicable after the accident, the board visits the job, whether it be in Detroit or elsewhere, and takes informal testimony from eye witnesses, the injured workman, if possible, the foreman and superintendent. I use the word "informal" because we invariably begin by stressing the fact that all present are there for the purpose of discovering how such conditions may be promoted as will effectually prevent a repetition of such an accident and therefore they may all speak freely. The effect of this practice is very excellent in many ways, particularly in re-establishing confidence and, therefore, efficiency on that job.

Co-operate with Council and U. S. Department of Labor.—All of the foregoing will indicate to you that the systematic methods that we have developed and adopted for the control of accidents have resulted in a sort of unwritten book of standard rules and processes among the association members, and the various jobs of each member. Standard methods, plus discipline, its first cousin, must surely result in efficiency, and it follows just as naturally that efficiency based on organization and system makes for minimum accident occurrence. This, in a word, is success which in safety work means humanitarianism, economical as well as physical safety to workmen with a resulting speed and economy to both the owner and the contractor.

Without statistics of a high order, our work in safety methods could not be capable of being measured. To this end, we have worked carefully with the United States Department of Labor, the National Safety Council and others to perfect and adopt standard methods of accident accounting, and the adoption of forms with standardized nomenclature of cause and result of accidents with standardized penalties in elapsed days for fatal and permanently disabling accidents. I believe a great deal of credit for these standardized methods of accounting is due to the National Safety Council because it is now possible to make results in one section comparable with those elsewhere, and is an inestimable help to those who are making a sincere and intelligent effort to reduce industrial accidents and their results in the construction industry.

Accident Prevention an Essential.—I wish to repeat what I said in the beginning; that our members have been so completely sold on the subject of accident prevention among employes through the methods outlined in the foregoing that they regard it as an essential department of their business along with economy and efficient handling of any other department. Safety is not the privilege of the large contractor, for he has no patent or special advantage over the small contractor. Nor do we agree that the phrase I dimly remember, "a death a floor" should be stoically accepted, for while we occasionally have deaths, we have completed many multiple story buildings on which the death column in the accident record is blank. We have both large and small contractors, and I am convinced through my knowledge of accident occurrence in the construction industry that accident prevention is exactly as important, no more and no less, to the small as well as to the large contractor, and that the methods of controlling and minimizing accidents are as much available to the one as to the other.

We have had a small measure of success in preventing accidents. But it is a matter of common discussion in our committee that our work has only nicely begun and that "every day in every way" we expect to become better and better.

Union Workers in Building Industry.—Official tabulation of the membership of the affiliated international unions in the building industry shows a total of 502,132 craftsmen, exclusive of the carpenters union, which has a membership in excess of 350,000.

Waterproofing Processes for Preservation of Masonry Walls

Various Methods and Processes Described in the October Issue of Stone

Weather is Nature's wrecker and the value of various materials for construction work depends upon the degree to which they resist its ravages. In certain climates where there is little or no moisture in the air and where rains are of infrequent occurrence, little attention need be given to "weathering" or to methods to arrest decay. In some sections of the United States this condition obtains, while in others exactly the opposite holds good and waterproofing, or damp-proofing is resorted to in an effort to preserve masonry walls from disintegration due to moisture in the pores of stone and other building materials.

Two Main Problems.—In the work of rendering a masonry wall waterproof and thereby arrest disintegration two main problems must be met and corrected before applying any one of a number of profing agents. First, all leaks must be located and sealed and, second, the wall must be restored, disintegrated sections removed and new materials inserted and all joints pointed before any waterproofing material can be applied with the hope that it will prove successful. The fact that many paterproofing jobs are not executed with care and by experienced workmen usually is the direct cause of the failure of an otherwise efficient process and material.

Waterproofing or damp-proofing is not "painting," but rather a combination of painting, pointing, repairing and cleaning, for it is essential that all exposed parts of a wall, including tops and backs of parapets, should be pointed and the walls themselves cleaned down to insure adherence of, or penetration of the waterproofing substance. While all experienced waterproofers insist upon walls being dry, one process is based upon the theory that the stone must be thoroughly dry, that the pores must be free from moisture to the depth of about ¼ in., to insure perfect and uniform penetration of the preserving material, which in this instance is paraffin wax in combination with another wax. To obtain the required temperature charcoal furnaces of an open-face type are used to bring the wall surface to a temperature equal to that of the melting point of the wax compound.

Treatment of Central Park Obelisk.—It was this process that was used in 1885 in the treatment of the Obelisk in Central Park, New York City, when park officials became alarmed at the rapid disintegration of the famous shaft. So far advanced was this disintegration that the waterproofers found it necessary to remove 850 lb. of flakes or chips. The entire exposed surface was then treated by the heat pocess with a paraffin wax compound, which congealed in the pores of the stone in the process of cooling and formed a protective belt course about ¼ in. deep that has been pronounced impervious to dampness. At least the decay ceased, the flakes no longer appeared on the surface and the shaft apparently was saved. In the period from 1885 to 1923 no further treatments were given to the shaft, but in the latter year the surface was coated with a liquid as a precautionary measure, and as no new flakes had appeared or other signs of disintegration manifested themselves, the Park Department officials were of the opinion that the original paraffin wax impregnation process had served to preserve the shaft for all time.

Paraffin in a molten state in combination with another wax or waxes, or in solution with some volatile oil or liquid, constitutes the base for the majority of the prepared waterproofing and damp-proofing compounds on the market today. Where this paraffin preparation is applied to a wall surface under heat the temperature of the stone must be raised to a point sufficiently high to dry out the wall, usually from 160 to 180° F. As paraffin will melt at 140° the theory is that it will penetrate into the pores of the stone and mortar at that temperature. Once in the pores the wax congeals, fills the pores and cannot be removed except under a temperature high enough to vaporize it, or 600°. Paraffin in solution is applied at outside temperatures and is therefore a more efficient agent when the work is done in summer, or when the average temperatures are around 50 to 60°, or higher. It cannot be applied during cold or freezing weather, nor immediately after rains, or during fogs, and periods of dampness. Thus

the season for waterproofing by this process is confined to the five or six months of non-freezing weather. The liquid is applied with a brush. On dry walls compounds of this nature have been tested and the penetration has been quite uniform and to a sufficient depth to form a damp-proof surface. On exterior marble walls one coat is held to be sufficient to arrest weathering, while limestone requires two coats. As some stones discolor under this treatment it is good practice to consult chemists or manufacturers before risking the application of any waterproofing product of which paraffin is the base and in which oils are added in solution. The action in both the artificial and the outside heat processes is purely a physical one and neither the stone or the mortar joints are weakened, but rather strengthened and the color tone fixed. Paraffin in solution or when applied under heat is recommended as a preventive from discoloration from smoke and soot. The paraffin coat presents a smooth surface that is easily cleaned and which at the same time eliminates gases responsible for the formation of acids in the pores.

An English Method.—An English method that has been brought forward, but with what success is not known, consists of a solution in water of barium hydrate, saturated at summer temperatures when it contains about 3 per cent of byrata. Various objections have been raised to the use of this process, chiefly because it is a compound that is decidedly toxic and workmen needs must be protected while applying it. The application of silica of soda to freestones to give impervious surfaces has been used in England. It is probable that many patent preservative compounds are made of soluble silicate to which is added some material, such as pulverized quartz, which helps fill the pores. A number of years ago the so-called Tubelka method was given considerable publicity. It provided for the use of 1.7 solution of waterglass for tempering and after the stone became dry, to saturate it with a solution of potash or soda waterglass. This was to be followed with impregnation of molten chloride of calcium. Moisture, it was claimed, could then do no harm, as the reaction of chloride of calcium upon waterglass filled the pores with insoluble hard silicate of lime. while the soluble silicate of lime decomposed and washed out by rain. Another prcess of the same origin provided for saturation of the wall surface with a solution of potash waterglass. An objection to this was that it must be repeated several times to properly fill the pores.

Resistance of American Type Office Building in Tokio to Earthquake Damage

Reports made by the engineers of the George A. Fuller Co., New York, which had erected in Tokio three large office buildings of American type, show that the earthquake damage to these buildings was mainly superficial. All three were heavily graced from designs prepared by H. V. Spurr of Purdy & Henderson, engineers, New York, as shown in the Sept. 26 issue of Engineering and Contracting. Extracts from the reports are given in the Nov. 15 Iron Age as follows:

From Preliminary and Superficial Examination (Entirely From the Outside)

Marunouchi Building.—Many cracks in brick and concrete filling between the steel columns on the second and third floors. Outside tiling had been badly buckled in many places and falling off, but this tiling was simply ornamental and added nothing to the strength of building. Steel frame work appeared to be absolutely intact without any shifting of position. No window glass was broken.

N. Y. K. Building.—Steel frame aboslutely intact with no shift, considerable damage to brick walls and terra cotta between the steel columns on the second and third floors, most of which occurred on the corners; also some of the exterior terra cotta was badly cracked on upper floors. The interior walls on first floor showed no cracks nor was any window glass broken.

Japan Oil Building.—Steel frame intact with no shifting, some damage on second and third floors to the brick and terra cotta between steel columns, but considerably less than on the other buildings; also considerable of the terra cotta showed cracks on the

upper floors and a few of the granite base blocks were cracked. No window glass was broken, but from the outside view there were indications that a portion of the hollow tile partition walls on first floors had fallen down.

Seiuyukai (Under Construction).—Small damage, as the walls were not cracked, but some damage from the fire caused by scaffolding burning; no indication, however, of any interior damage to partitions or walls, and work on this building can be resumed at once.

From Engineer's Thorough Examination

Structural Steel.—The steel frame in every case (in all three completed buildings) seems to have been of sufficient strength to withstand the dead loads and the sudden application of any superimposed loads due to vibrations caused by the earthquake and also seems to have shown a sufficiently high elastic limit to have returned to its original position in every case. That there was undoubtedly a marked momentary deflection laterally in the columns is evidenced by the shattering of a large percentage of the masonry piers surrounding or inclosing the exterior wall columns, and of the plastered partitions between the steel columns of the interior (and the distortion or destruction of the steel cross bracings which were added to the Marunouchi Building after the earthquake of 1922). While the momentary and violent deflection of the columns laterally, particularly in the second and third stories, was of sufficient strength to shatter the inclosing or contiguous masonry, the agitation was not sufficient to distort the structural steel permanently in any case.

Reinforced Concrete.—Except where the principal bays or sections of the parts of each building were joined together, such as the front of the side wings, there was no evidence of any destruction or distortion of the reinforced concrete floor slabs. At the joints between the front and side wings there were some minor cracks in the floor construction showing through the corridor floor surfacing, and indicating that the several sections of the building vibrated independently from each other, the cracks being undoubtedly due to a very severe shearing stress at these points.

In the Marunouchi Building there does not appear to be any marked or serious damage to the reinforced concrete floor slabs or beam coverings. Where reinforced concrete walls were used on the interior there was a minimum amount of damage, except at certain points on stairway walls near the west side of the building. This damage was probably due to the lack of continuity of these walls in a straight line.

Recommendations

as to the design of buildings to be erected in locations subject to earthquake shocks.

Structural Steel.—Columns should be placed in straight lines in each direction so that at every panel there will be a maximum number of points of resistance. The sections of columns should be as wide as possible in each direction and should be connected at each floor by girders as deep as the requirements for head room will permit. Both columns and girders should be latticed if the computation of stresses does not require solid web plates. If solid webs are required then the webs should be punched at frequent intervals to permit of the proper application of reinforcing steel. Between the girders at each floor will be the necessary steel beams for carrying the reinforced concrete floor slabs.

In cases where head room or clear interior spaces are absolutely necessary then resort must be had to knee braces. It is recommended, however, that such rooms as absolutely require great height or clear interior be placed on the top story, or as near thereto as possible. Rivets for connection of girders to columns should be in shear wherever possible. Rivets in tension should be studiously avoided.

Conference on Housing.—The 9th annual conference of the National Housing Association will be held Dec. 5, 6 and 7 at the Hotel Adelphia, Philadelphia.

How Photographs Help Sell Construction Service

Photographs of construction projects can be of great help to a contractor in selling his services if he goes about the matter in the right way. Some of the larger construction firms take advantage of the assistance which pictures can render, but unfortunately, the majority of contractors—especially the smaller ones—fail to realize the desirability of taking pictures, even for their own records. Such contractors will perhaps be interested in the experience of one large firm—Dwight P. Robinson & Co., of New York, and other large centres—who have found photographs useful in getting business. They explain their system as follows in the Contract Record:

Progress photographs, as used and developed in our work, form a part of the mechanism for reporting and recording construction progress. In fact, they are so much a part of the daily routine that we are surprised to find that the layman frequently considers their use as somewhat of an innovation.

These photographs have three main purposes: first, reporting the progress of the work to the client; second, providing a permanent record of the status of the work at given dates, and third, assisting the executives in the New York office in controlling the progress of the work. Incidentally, progress photographs have been found useful in giving prospective clients a graphic view of our activities. This last use is, of course, not considered in taking routine progress photographs, but their value for this purpose has been so well demonstrated that some suggestions regarding the use of photographs in selling may not be amiss.

Our salesman faces a peculiar task in that the commodity which he sells —service—cannot be made visible like material or equipment. His appeal is wholly to the reason—and expressive photographs help to give a quick impression and strengthen a sound argument. The photograph enables him to deliver his message through two senses instead of one.

For selling purposes we need mostly, of course, photographs of completed structures, both exteriors and interiors, and from as many different viewpoints as are necessary to show every interesting detail about the job. Detail photographs of equipment installations are particularly desirable. An industrial power plant of small size, for example, should be treated just as thoroughly as a large plant, and the installation of all the principal units photographed. Such comparatively small details as shaft hangers, railings and interior partitions are well worth photographing. A novel construction method or detail also makes a desirable photograph. In all photographs for selling purposes the place should be cleaned up before the photograph is taken and the scene should be arranged as nearly as possible as it will be when the plant or building is in actual use. It is scarcely ever desirable to have men appear in the photograph, but when they do they should be required to attend strictly to business and not to appear as though they were having their pictures taken.

Improved Apparatus for Testing Bricks

An improved apparatus for the transverse testing of brick has been designed by H. L. Whittemore of the U. S. Bureau of Standards. During the past month 500 brick were tested to determine whether this apparatus was superior to that specified by the American Society for Testing Materials. Two hundred and fifty bricks were tested in each apparatus. The bricks were of three different kinds, 200 being clay brick, 200 cement, and 100 sand-lime brick. The average results were practically the same for both types of testing fixtures, but with the Whittemore apparatus it was possible to test 100 bricks in 3 hours, while 5¼ hours were required to test the same number with the A. S. T. M. fixtures. With the latter apparatus, five pieces are displaced when a brick is broken, and these must be accurately replaced in position for the next test. There are no displaced parts when a brick is broken in the new holder. Since both devices give equal results for the modulus of rupture of a brick, and since the A. S. T. M. fixture requires more time, the new apparatus is believed to be an advance in the field of testing equipment.

How the Consumer Wastes Millions of Feet of Lumber Annually

At a recent meeting of the Practical Size Investigating Committee, which was appointed by the Consulting Committee on Lumber Standards, co-operating with the U. S. Department of Commerce, the secretary, T. F. Laist, who is architectural adviser of the National Lumber Manufacturers' Association, reported some interesting facts.

The waste due to the insistence of the public on buying lumber only sawed to even lengths resulted in a total waste of approximately 140,000,000 ft. of sawed timber annually. This represents the average annual growth of over 2,000,000 acres, equal approximately to one-half of the area of the State of New Jersey. This figure may be compared with the original eastern forest region of 68,000,000 acres, but of which only 60.7 million acres now remain, and with the western forest region of 140.8 million acres of which there remain 77.4 million acres.

Some 310 examples of house plans were analyzed to show that the consumer actually, although he demands even lengths, saws over 50 per cent of joists purchased into odd lengths. The plans upon which this deduction is based are divided into five groups: (1) those which may be classed as better class homes designed by architects, (2) ready-cut houses, (3) builders' designs, (4) plan books and builders' plan service, and (5) high-grade architects' plans. It was found that the waste due to this cause was not confined to the architects, but that the builders are equally negligible in getting the most out of their timbers. Thus in the first group 57.3 per cent of the joists were odd lengths, in the second 55 per cent, in the third 61 per cent, in the fourth 55 per cent, and in the fifth 50 per cent, making an average of 54.5 per cent in all the examples examined. The percentages which could be saved had the builder been able to purchase the joists in odd lengths would have been as follows: 4.3, 4.4, 5.1, and 3.6. The variation in these percentages is due to the fact that in the most expensive homes the longer length joists are used so the percentage of saving in the long joists is smaller, the maximum saving in each joist never being more than 1 ft.

In studs the waste due to even lengths is also large, but not as great as in joists. It was found that in some sections the 9 ft. stud was used extensively.

In boards the odd lengths are not as useful with the standard spacing of 16 in. as the even lengths. Thus, with 5, 7, 9, 11, 13 and 15 ft. boards the waste would be 20, 5, 10, 4, 7 and 3 per cent respectively, while the even lengths in 4, 6, 8, 10, 12, 14 and 16 ft. the percentage of waste would in each case be less than in the nearest odd lengths. Therefore, there would be little use for odd length boards if joists were always spaced regularly, but openings were almost invariably placed so that a percentage of odd lengths may be used for the same reason. Short lengths may be used to a large extent. The percentage of short lengths used in an average building is variable, but generally amounts to from 25 to 30 per cent or more.

In view of the above and other facts the committee recommended that manufacturers produce standard studs in lengths of 9 and 11 ft., in addition to the even sizes now produced; that dimension lumber be produced in lengths as follows: 2x6, 9 and 11 ft., 2x8, 9, 11 and 13 ft., 2x10, 13 and 15 ft., in addition to the length now on the market.

The practice of only using even lengths which has always prevailed in this country causes not only the waste at the buildings, as above indicated, but also the corresponding waste at the saw mills. The lumber manufacturers saw logs in 16 ft. lengths. If a defect appears near the end of the 16 ft. piece it is now necessary for him to saw off full 2 ft., while under the new rule, if adopted, in many cases, the loss will only be 1 ft. In a similar way short pieces are produced where these may come from the slabs due to the taper of the log. A large percentage of these short lengths are now burned because no market can be found for short lengths owing to the prejudice of the retailer and the consumer. Investigations carried on by the Forest Products Laboratory some years ago showed that, based on observation in six mills, the waste due to even length manufacture in saw mills and planing mills amounted to 7.29 per cent of the whole. Of this

a certain per cent was necessary waste. The unnecessary waste being equal to 1.27 per cent.

The committee that made these recommendations was composed of the following:

E. S. Hall, Chairman, Architect; Wm. A. Babbitt, Secretary, National Association of Wood Users; E. S. Curtis, Millwork Manufacturer; John Foley, Forester, Pennsylvania Railroad; Frank Ward, Retailer; J. E. Jones, Chief Inspector, Southern Pine Association; T. F. Laist, Secretary.

82 Years of Building Costs

Survey Covering Period 1840-1922 Summarized in The Constructor

An interesting review of construction costs from 1840 to 1922, which has just been completed by the Southern California Chapter of the Associated General Contractors brings out the following pertinent facts:

The construction industry of the country as a whole is no longer affected by the extreme price fluctuations which prevailed during the period of the World War.

If prices of building materials ever again reach their pre-war levels, it will only be after many years.

The review shows that in the Civil War period, just as in the World War period, the cost of building throughout the nation increased enormously and that this increase was very largely due to higher prices for materials rather than to higher wages demanded by the building trades workers.

Post-War Levels.—The review also shows that although wages went up more slowly and relatively much less during the Civil War, they afterwards came down more slowly and relatively not so far as the prices of materials. In fact, although the cost of building materials was almost exactly the same in 1898 as in 1850, wages of building labor were about twice as great in the later year as in the earlier year.

Investigations of the local chapter of the contractors' national organization in an effort to obtain an accurate and exhaustive survey of construction costs during the 82 years from 1840 to 1922 disclosed that the difference in the behavior of wage rates and prices of materials was due to a great fundamental cause which has been operating throughout this period and is still operating even more powerfully now than it was decades ago.

The Basic Cause.—This fundamental cause is the constantly increasing use of labor-saving machinery and methods which are constantly increasing the per capita production of commodities and thereby increasing the quantity of the desirable things of life to which each individual is entitled. It therefore follows, the review states, that if the prices of materials remain relatively constant wage rates must continually increase in order that the workers may be able to purchase their increasing share of these products.

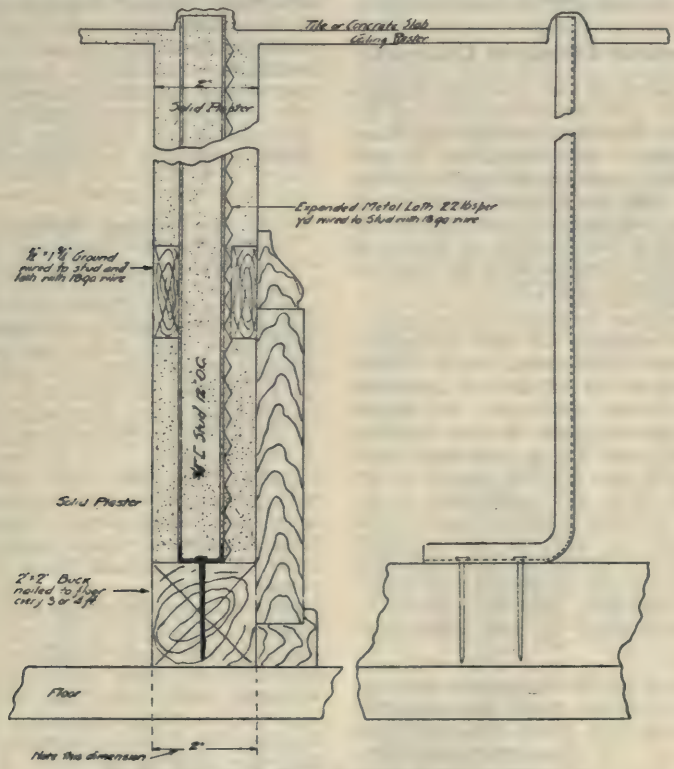
The chapter's survey discloses also that following the Civil War peak and the subsequent depression there was, beginning with 1870, a period of about two and a half years during which the price of building materials increased and the general cost of building increased likewise during this period. Although this condition is paralleled by a smilar rise in prices at present, the review states, it is not safe to figure on a close parallel between the course of prices in the present period and those which prevailed following the Civil War because of many important conditions of the present period which are widely different from those 75 years ago.

Prices of Materials.—One of the numerous interesting facts shown in the chapter's review is that the cost of building materials only once between 1840 and 1922 descended below the level of the cost of building trade wages. This was in 1915, just prior to America's entrance into the World War. At this time wages were slightly in excess of the cost of materials, but remained at this level only a brief time, dropping beneath material prices between 1916 and 1920.

The two highest peaks in the costs of both materials and wages between 1840 and 1922 were 1864 and 1919 to 1920. The normal fluctuations in the costs of both materials and wages prevailing prior to the Civil War ceased about 1860 and turned sharply upward until 1864. From the latter date there was a gradual downward trend until 1897. Between 1897 and 1915 wages and materials climbed gradually with a very few fluctuations. But in 1916, just as in 1860, the prices went up with a sharp ascent until 1920, at which time the downward trend began.

A Space Saving Partition

The 2-in. solid plaster, metal lath partition shown below was designed by the Swetland Co. of Cleveland in co-operation with The Cleveland Association of Building Owners and Managers and The Associated Metal Lath Manufacturers. This type of partition has been used successfully in several Cleveland office buildings. It not only saves space, but it is economical to erect. The drawing shows the detail of construction. Attention, however, is directed to the fact that the wood grounds may be nailed together by long nails, bent over and clinched. If picture moulding or cornice is erected at the ceiling line instead of below the ceiling line, it may be advisable to have a 2x2-in. buck at the ceiling. The channel studs may be attached to the floor buck by boring holes ¾ in. in diameter in the buck and inserting the stud in these holes. It is essential to have a steel channel stud on each side of the door buck.



Detail of Swetland Type of Space Saving Partition.

Tests of Caustic Magnesia Made From Magnesite From Several Sources

The results of a part of the U. S. Bureau of Standards work on oxychloride cement are contained in Technologic Paper No. 239, which may be obtained from the Superintendent of Documents, Washington, D. C., at 10 ct. a copy. Comparatively few users of this material are really familiar with it. Even among architects and builders oxychloride cement products are often known only in connection with trade names. The rapidly increasing demand for these materials shows that they possess certain desirable peculiarities, and has made it necessary to replace haphazard or "rule of thumb" methods in the manufacture and use of this cement with more scientific methods based on the study of numerous tests. Caustic magnesia, the chief constituent of oxychloride cement, was made in the experimental cement plant of the

Bureau of Standards by calcining magnesite ore. The temperature and other conditions were varied in order to study the effects on the properties of the product. An ore imported from Greece, one shipped from the state of Washington, and two from different mines in California were used, as these were representative of the chief sources of supply for this country. Cement mixtures, typical of those used by the trade, were then made, and tested both in the laboratory and on panels of flooring and stucco exposed to actual service conditions.

Arbitration Clause in Contracts

Acceptance of the principle of arbitration by the representatives of the American Railway Engineering Association and a reconsideration of certain other contract principles which pave the way for a general agreement was the outstanding accomplishment of the Joint Conference on Standard Construction Contracts at its meeting in Washington, Nov. 19.

The railway engineers submitted a detailed criticism of the documents previously formulated with which they were not in full accord and those matters which could not be immediately agreed upon at the meeting were referred to a sub-committee, which will render this report about Dec. 10. The sub-committee is instructed to reach a basis for universal agreement on each of the contract provisions referred to it, redrafting these provisions, if such a course becomes necessary, and to submit its recommendations to the conference for approval.

As a result of discussions and exchanges of ideas which has occurred during the past year, the sentiment among all of the representatives actively participating in the conference is stated to have crystalized in favor of an arbitration clause. Thus the last serious obstacle to general agreement and formulation of the universal contract documents appears to have been removed.

With the exception of the National Association of Builders' Exchanges, which has not yet rendered a definite report, the entire conference is in agreement upon the building documents. There now appears little doubt that within the next few months unanimous agreement will be reached in the conference upon both the building and the railroad documents and that work will proceed upon other forms. The next to be undertaken will doubtless be a form for general engineering construction or work under charge of an engineer, other than what may be designated as public construction.

Associations represented on the joint conference are: American Association of State Highway Officials, American Institute of Architects, American Railway Engineering Association, American Society of Civil Engineers, American Water Works Association, Associated General Contractors of America, Federated American Engineering Societies, National Association of Builders' Exchanges, Western Society of Engineers.

U. S. Government Specification for Gloss Interior Lithopone Paint, White and Light Tints

The U. S. government's specification for gloss interior lithopone paint, white and light tints, has just been issued as Circular No. 147 of the U. S. Bureau of Standards, and may be obtained from the Superintendent of Documents, Washington, D. C., at 5 ct. per copy. As in the case of Circular No. 146, this specification was prepared by the technical committee on paints of the Federal Specifications Board, after carefully considering suggestions from manufacturers of this material. The specification covers paints not intended for outside exposure, that will dry to gloss opaque coats which will adhere well to wood, metal and plaster, stand washing with soap and water, and show no material change in color on exposure to light, or material yellowing when kept in the dark. A general description of the pigment, vehicle and completed paint, which is a lithopone zinc oxide pigment in a vehicle of treated drying oils or varnish, is followed by detailed directions for sampling and testing. The tests cover caking in container, color, weight per gallon, brushing properties, time of drying, resistance to washing, fastness to light, yellowing, determination of water, volatile thinner, percentage of pigment, percentage of non-volatile vehicle, nature of non-volatile vehicle, coarse particles and skins and analysis of pigment.

The 1924 Building Situation

Preliminary Forecast Given in the October Issue of The Architectural Forum

There is given here a portion of an article by C. Stanley Taylor which appeared in the September Forum Bulletin.

While it is somewhat early in the year of 1923 to attempt a dependable forecast of conditions in the building industry during the year 1924, there are certain basic trends which would seem to indicate at least an intelligent guess as to what manufacturers in the building field may expect as a market for next year.

Before making a definite forecast of the volume of business to be expected during the ensuing year, it is the usual practice of The Architectural Forum to obtain in the early winter months a large number of confidential reports from architects and engineers covering the definite construction projects which form part of their program of activity. With this information it has been found possible to forecast with a fair degree of exactitude a volume and classification of building activity.

Lacking this information now, it is necessary to take several basic factors and to analyze them in order to provide the proper weight for a forecast of this nature.

It is, of course, necessary to eliminate from consideration any so-called economic phenomena, such as a strike in the coal field, railroad difficulties and similar elements which cannot be foretold. We may, however, consider the following important contributing factors which will make the building material market for next year:

1. Confidence of the investing public.
2. The trend of building costs.
3. The attitude of building labor.
4. The attitude of bankers and financial organizations through which a large percentage of the cost of new building construction is provided.

Public Retaining Confidence.—It is an interesting fact that in spite of the high cost of building and the vast amount of publicity which has been given to this subject, there still remains on the part of the building public a very definite element of confidence in the situation. One reason for this may be attributed to the success of speculative and investment ventures which have been embarked upon during the last two years and which have continued almost without cessation up to the present time.

During the last two years industrial building has shown surprising and unexpected strength. Similarly, residential and special types of building have been extremely active and the investment in all classes of construction has exceeded any record of past years.

Better Grade Building.—The great waves of speculative building and cheaply constructed investment building have passed finally with the year 1923, and it is obvious that before building investments are made very serious consideration will be given to the character of such an investment.

In the speculative and investment building field, financial interests have reached practically the same conclusion; i. e., that the so-called "shoestring" builder should be discouraged and that financing should be limited to sound types of housing and mercantile buildings. Consequently, the year 1924 will show a much more intelligent purchasing attitude. It is evident that there is not to be the wild scramble for building material and equipment which we have experienced during the past two years. Quality will mean more, and much greater stress is to be placed upon the economic value of good design and the purchasing of dependable materials and equipment.

We anticipate very little building of the cheap class in which the primary influence on specifications has been low price. This period is passed and it is expected that the architect and engineer will exercise a greater influence than ever before on the character and quality of the materials and equipment which enter into the construction of new buildings during next year.

Ample Mortgage Money.—We have had an unusually good opportunity to discuss the building situation with a

number of the larger institutions devoted exclusively to the pacing of mortgage money. We find in all quarters an optimistic attitude with a clearly expressed determination to finance only those projects which are good enough to meet the market rental and sales competition of the years to come.

It is important to realize that practically all of the larger mortgage-bond companies have recently finished or have now under construction new buildings to house their activities in important centers, such as Chicago and New York. This certainly indicates confidence in the building situation for several years to come. We are informed that there is no sign of decreased confidence on the part of the investing public which purchases bonds (except the seasonal influence of summer months).

The Price Trend.—In the building material field we look for certain interesting developments. It is our opinion that the price trend will be strongly influenced by merchandising competition, which calls for some price reduction but, primarily, an accentuation of quality both aesthetic and integral. We believe that 1924 will show the beginning of a period of elimination of cheaper competition and the exclusion of many weakly organized building-material producing companies, which without proper financing cannot stand the gaff. Prices will stabilize and perhaps move slightly downward.

A considerable amount of discussion has recently developed in regard to the importing of basic building materials, such as brick, cement, glass, and even architectural woodwork. This is an element to be considered, but we feel that its primary influence will be to stabilize the price of American production and that at best such competition is of a very temporary nature.

Stabilizing Demand.—A definitely false note was introduced into the building-material field this year by the unsound practice of over-ordering, the fallacy of which has already been proved to both parties concerned.

Having been reassured as to the availability of materials and to promptness of delivery, it is evident that building contractors will not duplicate and triplicate orders for 1924 in order to safeguard themselves on delivery.

Building Labor Conditions.—The general attitude of labor in the construction industry is something which no one has ever forecast successfully. From close personal contact with a fairly representative cross section of skilled labor it would seem that labor rates for 1924 will not change noticeably, but there is a distinctly recognizable tendency on the part of the average building mechanic to provide a really good volume of production for the wages he receives. This we believe is to be an evident factor in the labor situation for 1924; that the men will be well paid but that on the average a real day's work may be expected from the mechanics, both on the job and in the plant. In practically all of the more important building centers skilled labor rates for the year 1924 have already been established by agreement, and we anticipate less economic waste in the form of strikes than during any normal building year since 1912.

Anticipated Volume of Building.—There can be no question but that building activity in 1924 will exceed by a considerable amount the average expectation of three billion dollars a year.

Casual reports and information gained in contact with architects and engineers throughout the country indicate that there will be considerable activity in the hotel field, particularly hotels ranging from $200,000 to $500,000; that residential construction will continue in at least two-thirds the volume of this year, and from all indications there will be increased activity in the development on industrial plants.

Ample mortgage financing on a conservative basis is available to provide a five billion dollar building program for 1924. We do not anticipate that the figures will reach this amount, however, but we do expect that there will be a great increase in the volume of investment in high-class buildings, well designed and using recognized materials and equipment of quality.

Monthly Statistics of the Building Industry

The accompanying tabulations are taken from the Survey of Current Business, a publication of the U. S. Department of Commerce. They show (1) the building contracts awarded by thousands of square feet, and thousands of dollars, (2) the index numbers for building contracts awarded, (3) the building material price index for frame and brick houses, (4) the cost index for constructing factory buildings, and (5) the index numbers of wholesale prices for structural steel, iron and steel, composite steel and composite finished steel.

The figures on building contracts are based on data compiled by the F. W. Dodge Co., covering small towns and rural districts as well as large cities in 27 northeastern states. Prior to May, 1921, the building figures covered 25 northeastern states and the District of Columbia. The states are those north and east of, and including, North Dakota, South Dakota, Iowa, Missouri, Tennessee, and Virginia, together with portions of

	Grand Total Building Contracts		Index Numbers		Building Material Price Indexes		Cost Index	Wholesale Prices Index Numbers			
Year and Month	Thousands of sq. ft.	Thousands of dollars	Sq. ft.	Value	Frame house	Brick house	Factory building costs	Structural steel beams (Pittsburgh)	Iron and steel	Composite steel	Composite finished steel
1913 monthly av.	.....	$71,475	.....	83	100	100	.....	100	100	100	100
1914 monthly av.	.....	60,020	.....	28	.....	.....	100	83	87	88	86
1915 monthly av.	.....	78,341	.....	36	.....	.....	.....	93	94	95	92
1916 monthly av.	.....	113,082	.....	53	.....	.....	.....	177	154	163	161
1917 monthly av.	.....	134,086	.....	63	.....	.....	.....	269	266	259	252
1918 monthly av.	.....	140,770	.....	65	.....	.....	.....	202	215	220	213
1919 monthly av.	46,683	214,990	100	100	.....	.....	.....	174	191	193	188
1920 monthly av.	33,491	211,102	72	98	.....	.....	.....	187	249	211	222
1921 monthly av.	32,267	196,648	69	91	.....	.....	179	131	155	156	152
1922 monthly av.	47,745	279,410	102	130	182	186	170	115	144	134	134
1921											
January	15,513	111,608	33	52	.....	.....	.....	.....	.....	.....	.....
February	16,807	100,677	36	47	.....	.....	.....	.....	.....	.....	.....
March	26,709	164,092	57	76	.....	.....	.....	.....	.....	.....	.....
April	34,494	220,886	74	103	.....	.....	.....	.....	.....	.....	.....
May	35,751	242,094	77	113	.....	.....	176	146	165	170	166
June	35,738	227,711	77	106	.....	.....	172	146	159	165	159
July	31,717	212,491	68	99	.....	.....	167	139	145	153	148
August	35,246	220,721	76	103	.....	.....	161	123	137	144	141
September	41,702	246,186	89	115	.....	.....	160	123	134	138	136
October	40,436	222,480	87	103	.....	.....	157	116	135	134	134
November	37,818	192,311	81	89	166	173	154	106	132	133	128
December	35,272	198,518	76	92	173	179	153	99	129	130	127
1922											
January	30,261	166,320	65	77	174	179	152	99	127	126	124
February	30,061	177,473	64	83	169	174	152	99	125	124	121
March	51,957	298,637	111	137	169	173	152	96	125	122	122
April	58,146	353,162	125	164	168	172	152	99	131	126	125
May	53,639	362,590	128	169	173	176	157	106	139	127	127
June	60,526	343,440	130	160	178	181	169	106	140	129	130
July	51,705	350,081	111	163	181	184	171	109	142	130	131
August	54,019	322,007	116	150	189	193	174	116	151	137	138
September	44,275	271,493	95	126	193	197	190	137	166	146	146
October	46,806	253,137	100	118	196	199	192	141	166	149	148
November	46,946	244,366	101	114	196	201	192	136	160	149	146
December	33,603	215,213	83	100	192	198	192	132	154	149	147
1923											
January	38,947	217,333	83	101	195	199	192	132	156	151	149
February	41,611	229,938	89	107	198	201	197	139	162	158	157
March	54,920	333,518	139	155	209	209	197	146	171	165	163
April	64,527	357,475	138	166	206	209	204	172	179	174	169
May	60,430	374,400	129	174	212	214	208	174	180	176	168
June	46,344	323,559	99	150	212	215	206	169	177	176	168
July	42,021	274,224	90	128	214	217	206	166	172	176	167
August	39,786	253,106	85	118	215	216	206	166	170	176	167

eastern Kansas and Nebraska. Beginning May, 1921, North Carolina and South Carolina were added to the list, but this addition is stated to have little effect upon the total.

The price indexes for frame and brick houses are from the U. S. Department of Commerce, Bureau of Standards, Division of Building and Housing and Bureau of Census, and are based on prices paid for material by contractors in some 60 cities of the United States. The prices are weighted by the relative importance of each commodity in the construction of a 6-room house.

The index number for constructing factory buildings is furnished by Aberthaw Construction Co., and is designed to show the relative changes in the cost of constructing a standard concrete factory building. The company believes that the year 1914 gives a normal base and that July, 1920, with an index number of 265, represented the peak of costs.

The index numbers of wholesale prices for structural steel, etc., are obtained as follows: The prices for structural steel beams are the average of weekly prices from the U. S. Department of Labor, Bureau of Labor Statistics. The figures for iron and steel are the average of weekly prices compiled by the Iron Trade Review on the following 14 products: Pig iron, billets, slabs, sheet bars, wire rods, steel bars, plates, structural shapes, black galvanized and blue annealed sheets, tin plates, wire nails, and black pipe. Pig iron average in turn is average of 13 different quotations.

The figures for composite steel are compiled by the American Metal Market and represent the average price per pound of steel products weighted as follows: 2½ lb. bars, 1½ lb. plates, 1½ lb. shapes, 1½ lb. pipe, 1½ lb. wire nails, 1 lb. galvanized sheets, and ½ lb. tin plate.

The composite price of finished steel products is compiled by the Iron Age. It includes: Steel bars, beams, tank plates, plain wire, open-hearth rails, black pipe, and black sheets. These products, according to the Iron Age, constitute 88 per cent of the United States output of finished steel.

Statement of the Ownership, Management, Circulation, Etc., Required by the Act of Congress of August 24, 1912,

of BUILDINGS monthly issue of ENGINEERING AND CONTRACTING, published monthly at Chicago, Ill., for October, 1923.

State of Illinois, County of Cook, ss.

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared E. S. Gillette, who, having been duly sworn according to law, deposes and says that he is the Circulation Manager of the publication Engineering and Contracting, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Engineering and Contracting, 221 East 20th Street, Chicago; editor, H. P. Gillette, 221 East 20th Street, Chicago managing editor, H. P. Gillette, 221 East 20th Street, Chicago; business manager, Lewis S. Louer, 221 East 20th Street, Chicago.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.) H. P. Gillette, 221 East 20th Street, Chicago; Lewis S. Louer, 221 East 20th Street, Chicago; R. E. Brown, 904 Longacre Bldg., 42nd St. and Broadway, New York.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

E. S. GILLETTE, Circulation Manager.

Sworn to and subscribed before me this 1st day of October, 1923.

(Seal) KITTIE C. WOULFE, Notary Public.
(My commission expires Feb. 9, 1926.)

Roads and Streets

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.
221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*
LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 904 Longacre Bldg., 42d St. and Broadway
RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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Buildings—4th Wednesday, $1
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Vol. LX. CHICAGO, ILL., DECEMBER 5, 1923 No. 6

The Profits From an Improved Road

Before us is a thesis by Mr. J. L. Thayer, engineer, of Lincoln County, Washington, in which the author discusses the development of a highway system in a semi-arid and sparsely settled farming community. Obviously such a community is not wealthy, and before approving comparatively large expenditures for county roads, its members quite properly asked for evidence of the benefits to be derived.

In the case of one 11 mile improvement, the little community of Peach was called upon to bear 25 per cent of the total assessment. On the high grade orchard land the assessment was $50 per acre, and it may be imagined that it was not easy to secure the approval either of the farmers of Peach or of the owners of less valuable lands along the route. Sufficient support, however, was gained, and in the year 1922—the first following the completion of the road—the residents of Peach saved in costs of fruit hauling alone about one-third of their entire assessment. In addition to this there were other real, though less easily measured, financial savings, and all the added benefits of comfort, convenience and pleasure. We quote from Mr. Thayer's thesis:

"The argument that highways are needed for social, religious or pleasure purposes is not so convincing as the argument that highways are a good investment from a purely monetary standpoint. For instance, in Lincoln County, that highway known as Donohue Road No. 3, beginning at the town of Creston and extending 11 miles northeast to the town of Peach on the Columbia River, was constructed under an assessment plan, and the people of Peach owning 300 acres of irrigated orchard tracts were assessed for this improvement $15,000, or $50 an acre. The annual production of fruit at Peach is 84,500 boxes of apples, 42,500 boxes of pears, and 50,000 boxes of peaches. The owners of this fruit hire it hauled by truck to Creston. The road was completed in 1921, and in the fall of 1922 hauling the peaches cost 3 ct. to 4 ct. each box less than it had cost in 1921.

Hauling apples and pears cost 3 ct. to 5 ct. each box less. A simple problem in arithmetic will prove then that the actual saving to the people of Peach each year is approximately $6,000 in the handling of their fruit alone; therefore, for the people of Peach the road will pay for itself in less than three years. Assuming that instead of 25 per cent of the cost, they had paid 100 per cent of the cost, the road would pay for itself in 12 years."

This example is pertinent. It is not sufficient that the ignorant and unreasoned opposition of a generation ago have been largely overcome: it is still necessary, as it should be, to convince taxpayers that they will receive suitable returns upon their assessments. Examples like that of Peach show what can be done in some cases. Show a man an investment yielding 33⅓ per cent, or half that much, and hard up though he may be, he will generally find a way to raise the money.

The public grows more canny, and mere loud boosting becomes decreasingly effective. Its object may or may not be worthy. But add careful study and analysis to honest boosting and a really good project can generally be carried.

On Highway Financing

Titles may easily mislead, and long articles, unless known to have especial interest, are often shunned by busy men. Hence we here call attention to the paper, "The Problem of Highway Financing in America," by A. R. Hirst in other pages of this issue. Mr. Hirst has treated his prosaic subject in anything but a prosaic manner. History, psychology, ingenuity, wit, all play through and illuminate the economic discussion which, even by itself, is an attractive presentation.

One need not fully agree with Mr. Hirst in order to get both enjoyment and profit from his paper; but we believe that all must respect his fair and broadminded treatment. We ourselves disagree with him on several points and question others. For example, we think he has erred in using 4½ per cent to capitalize a hypothetical annual saving of $560,000,000. The capital requirement to effect any such yearly benefit would raise the interest rate very substantially. But such disagreements are secondary to the general discussion.

Mr. Hirst's statement that the motor fuel tax "approximates toll gate results without the infirmities of toll gate procedure" is most apt; and his treatment of highway costs as a part of our bill for the ownership and use of motor vehicles is so clear and sensible that we believe few can escape its logic. The paper as a whole is a real contribution to the subject of highway economics and progress.

Motor Vehicle Production

The U. S. Department of Commerce announces October production of automobiles, based on figures received from 186 manufacturers, 96 making passenger cars and 119 making trucks (29 making both passenger cars and trucks). Data for earlier months include 12 additional manufacturers now out of business. Figures on truck production also include fire apparatus and street sweepers.

AUTOMOBILE PRODUCTION
(Number of Machines)

PASSENGER CARS	1921	1922	1923
January	.....	*81,696	223,819
February	.....	109,171	*254,773
March	.....	*152,962	*319,770
April	.....	*197,224	344,639
May	.....	*232,462	*350,410
June	.....	263,053	*337,362
July	*165,616	*225,086	297,330
August	*167,756	*249,492	*314,373
September	144,670	*187,694	*298,911
October	*134,774	*217,566	334,966
November	106,081	*215,352	.....
December	*70,727	*208,010	.....

TRUCKS	1921	1922	1923
January	.....	*9,576	*19,720
February	.....	*13,350	*22,161
March	.....	*20,022	*35,260
April	.....	*22,640	*38,056
May	.....	*24,097	*43,678
June	.....	*26,298	*41,145
July	*11,136	*22,046	*30,663
August	*13,400	*24,692	*30,829
September	*13,978	*19,462	*28,632
October	*13,149	*21,795	30,141
November	*10,487	*21,949	.....
December	*8,656	*20,354	.....

*Revised.

New Highway Police System of Pennsylvania.—The motor patrol system of Pennsylvania which went into effect last month will have headquarters in 26 towns and cities. The patrolmen stationed in the municipalities mentioned will cover the territory within a radius of 30 miles of their headquarters. This method will result in an overlapping, which will increase the efficiency of the patrol.

Highway Finance

Digest of Committee Report Presented Nov. 9 at 3rd Annual Meeting of Advisory Board of Highway Research

A budget system as a definite part of the highway program is essential. Under the budget system a fixed amount of highway revenue is necessary for the construction of a relatively fixed amount of new mileage each year, the balance of the revenue being used for maintenance, reconstruction and betterments.

Any plan of state or county highway financing should conform as closely as local conditions permit to the fundamental rules which govern the raising of public revenue. (1) An equitable distribution of the burden between the contributing sources according to the benefit derived from the improvement and the differences in the ability to pay for the improvement. (2) Provide a definite amount of highway revenue yearly. This implies the highway budget system.

It should be emphasized that the use of credit does not solve the problem of distributing the highway costs between the several sources of revenue. The same sources of revenue which finance highway improvements when credit is not used must also provide the revenue to meet highway bonds when funds are borrowed.

The larger the amount of permanent highway investment in existence in a state the less the real need for the use of credit in financing the improvements. A second factor in determining whether to use present sources of revenue or make use of credit depends upon the wealth of a state and the ability to produce highway revenue from this wealth without unduly burdening it.

The problem of highway finance resolves itself largely into the question of a just distribution between the burden on land or real property and the burden on the highway user.

Real property taxation for highway purposes bears too large a portion of the burden of highway expenditures producing, in a survey of four Wisconsin counties, from 55 per cent to 70 per cent of the total highway revenue. The major portion of the burden on real property is due to local and county taxation of real property for highway purposes. In the four Wisconsin counties the local units produce 47.49 per cent; county units, 41.81 per cent, and the state 10.70 per cent of the real property revenue for highway expenditures.

The highway user whose demand for highway service is largely responsible for highway improvements should assume a larger part of the burden in the form of motor vehicle tax and gasoline tax.

Road and Street Contracts Awarded During the Last 46 Months

The accompanying table shows three outstanding facts: First, that highway contracts awarded during the last half of each year have averaged only 25 per cent less in volume than those awarded during the first half; second, that there is not a month in the year without a very large volume of road and street contracts awarded; third, that each year shows a substantial gain over its predecessor.

ROAD AND STREET CONTRACTS EXCEEDING $25,000 IN SIZE

	1920	1921	1922	1923
January	$ 12,204,000	$ 11,598,000	$ 14,424,000	$ 21,691,000
February	21,334,000	12,049,000	9,052,000	18,781,000
March	26,221,000	25,880,000	39,669,000	37,706,000
April	33,340,000	31,026,000	32,991,000	29,641,000
May	30,258,000	35,064,000	42,284,000	46,526,000
June	31,441,000	56,777,000	42,138,000	38,040,000
July	29,353,000	33,943,000	26,087,000	42,397,000
August	18,565,000	28,693,000	37,035,000	35,639,000
September	26,537,000	23,257,000	28,884,000	37,812,000
October	12,894,000	20,055,000	23,162,000	28,144,000
November	12,443,000	20,751,000	20,892,000	
December	10,834,000	16,263,000	18,096,000	
Total	$265,424,000	$315,356,000	$334,714,000	

Note.—About 100 per cent must be added to these totals to give the grand total of highway contracts in the United States.

Bridges are not included, and bridge contracts average 15 per cent as much in value as road and street contracts. A great deal of road and street work is done by directly hired labor and is not included above.

Traffic Over State Toll Bridges in Connecticut

Exactly 371,266 automobilists paid fees to cross the three trunk line toll bridges in Connecticut during July, August and September, in comparison with 339,917 during the same period a year ago, the state highway department has announced in making public a statement of receipts from toll bridges for the past summer. These three months have always been productive of greater revenue to the state than any others due to the large amount of summer motoring through the state and to the various shore resorts along the Sound.

Inasmuch as the collection of tolls on bridges will, by law, cease on Dec. 31, the statement is especially significant as it is the last summer during which motorists will be taxed to cross the bridges at Saybrook, New London and Haddam.

Comparative figures show that although twice as many Connecticut automobiles traversed the bridges as there were foreign cars, the traffic of out-of-the-state machines through Connecticut the summer season is very heavy, as shown by the following table:

	Foreign Cars	Conn. Cars
Saybrook Bridge	39,502	95,427
Haddam Bridge	3,164	28,166
New London Bridge	85,038	119,969
	127,704	243,582

Following is a comparative statement of receipts at the three bridges during the three months:

	1922	1923
Thames River Bridge—New London	$ 72,059	$ 72,566
Saybrook Bridge	56,131	58,370
Haddam Bridge	10,839	14,216
	$139,029	$145,153

Interesting data concerning the character of vehicles crossing the bridges is shown in the quarterly report. At New London, horse-drawn vehicles numbered 1,360, while 3,188 one-seated, 3,088 two-seated motorcycles paid toll. Small auto trucks numbered 22,355, and large auto trucks 1,729.

Over the Saybrook Lyme Bridge, the outstanding vehicle to cross was a three-horse vehicle, which paid a fee of 35 ct., with three passengers. Large auto trucks numbered 1,152 during the three months, and there were 8,592 small auto trucks recorded. Sixty-five one-horse vehicles crossed, as well as twelve two-horse vehicles.

The Haddam-East Haddam Bridge recorded the passage of two four-horse vehicles during the summer, together with 750 one-horse vehicles and 252 two-horse vehicles. Small auto trucks totalled 5,423, and those of larger size were recorded at 268.

Cost of Heating and Spreading Road Oil at Los Angeles

The following data on the operation of the oil heating plant of Los Angeles, Cal., are taken from the annual report of John A. Griffin, city engineer, for the year ending June 30, 1923:

This plant was designed and constructed by the engineering department of Los Angeles in 1918. The original cost of the heating plant, including the retort, was $11,872. Three oil spreading trucks were used, which cost $17,150. A garage to accommodate the trucks were built at a cost of $825. During the past year a new oil vat was constructed at a cost of $1,600. The total investment is nearly $32,000.

Table I shows the operative data and unit costs per barrel of oil product spread on the streets or otherwise disposed of.

The cost of heating and spreading oil with the city plant and equipment, given in the table, allows for all direct costs and overhead burdens, such as maintenance and depreciations of plant and equipment, superintendence and overhead administrations.

Table I
(Cost Per Bbl. of 42 Gal.)

Year	Output Bbl.	Oil	Heating	Spreading	Supt. & O. H. Admr.	Total Cost
1918-19	32,630	$2.02	$0.23	$0.25	$0.01	$2.51
1919-20	29,658	2.01	.37	.32	.02	2.72
1920-21	25,172	2.50	.55	.37	.03	3.45
1921-22	27,263	2.04	.40	.36	.02	2.82
1922-23	34,393	1.59	.36	.40	.02	2.37
Total and average	149,116	$1.99	$0.36	$0.33	$0.02	$2.70

Gravel Road Maintenance in Michigan

Methods and Costs on Trunk Line and State Reward Roads Given in Paper Presented Nov. 7 at Annual Convention of Michigan State Good Roads Association

By B. C. TINEY
Chief Inspecting Engineer, Michigan State Highway Department

We have in the trunk line and state rewarded road systems of Michigan about 12,250 miles of improved roads, of which about 9,250 miles, or 75 per cent, are gravel surfaced. The general distribution of gravel throughout the state, together with the comparative simplicity of construction and low first cost of this type account for the large percentage of gravel surfaces.

Tar Treatment on Gravel Road With Slag Cover. Photograph Taken 6 Weeks After Treatment. Daily Traffic Approximately 1,500 Vehicles.

Since the advent of the motor car in large numbers the maintenance of these gravel roads has become one of the most serious problems confronting highway officials of Michigan. The increase of the legal speed limit to 35 miles per hour has added, further, to the difficulty and cost of this maintenance.

How the Surface Is Kept Smooth.—The moisture content of the gravel is an important factor in the work of keeping the surface smooth, as shown by the ready formation of ruts and holes after a heavy rain and the tendency of the surface to ravel in very dry weather. The dry weather condition is probably the more serious, as it is usually coincident with the peak load of tourist traffic, and the patrol work is very ineffective without a certain degree of moisture in the surface.

Several types of graders and drags are used in patrol maintenance. A survey of this equipment in the state shows that 53 per cent of the counties are using horse-drawn machines en-

tirely, while the others have either wholly or partially adopted motor equipment. The larger counties prefer the motor equipment because of the greater efficiency in covering a large mileage. The grader or drag pulled by a tractor, or a the tractor and blade in one unit are used, also the 2 or 3-ton motor truck with a spring scraper attached underneath. This is very satisfactory if operated at a speed of not to exceed 8 or 10

Application of Priming Coat of Tar.

miles an hour, but does less effective work at higher speeds. The spring scraper is used only for floating loose material and should be supplemented by a heavy grader and tractor after rains, to plane the surface and eliminate ruts and holes.

Resurfacing With New Gravel.—The gravel surface is also kept smooth by an occasional resurfacing with new gravel. A satisfactory material for this purpose is that ranging in size from ¾ in. down and having about 75 per cent retained on a ⅛ in. screen. A partially crushed gravel has been found desirable. The application, if limited in depth to about an inch, will not be objectionable to traffic, and this represents about the minimum amount of gravel that should be returned to the road each year to replace that which is worn away. The road should have a covering of about ½ in. of loose material at all times, for efficient floating.

Oversize Stone Cause of Rough Roads.—One of the greatest enemies to smoothness in a gravel road is the oversized stone. Stone over 1 in. in size should be rigidly barred from the top course during construction, and certainly should not be permitted in any resurfacing material. The tendency of the large stone to work to the top by frost action is well known. Whenever a car strikes an obstruction such as a projecting stone, the springs are at first depressed and then expanded, lifting the weight of the car from the road. When the springs return to their original position the weight of the car strikes the road surface, causing small depressions. The spinning drive wheels also kick back some gravel and increase the tendency to form holes. This process continues and the holes grow rapidly in size and number until we have a whole series of corrugations or "chatter-bumps." Wet weather and flat grades are especially favorable to their formation, as water collects in the holes and is thrown out by traffic, carrying fine binder material with in.

Traffic and Dust Nuisance.—Perhaps the most disagreeable feature of the gravel road is dust. The discomfort not only to the motorist but to the resident along the road, together with the danger added to highway traffic by dust, make its elimination or reduction a matter of prime importance to highway officials.

On secondary roads having a traffic up to about 300 vehicles per day, the dust is not extremely objectionable. Our traffic census shows that of the 3,245 miles of trunk line gravel roads, we have about 20 per cent, or 650 miles, carrying a traffic of less than 300. About 35 per cent, or 1,135 miles, carry a traffic between 300 and 600, while about 45 per cent, or 1,460 miles, carry over 600. A census of the county systems would probably show larger percentages in the lower traffic divisions.

Those gravel roads having a daily traffic of more than 300 vehicles demand some form of dust elimination or reduction if they are to render 100 per cent service to the public.

Dust Palliative.—Two forms of dust palliative have been used in Michigan, namely calcium chloride and light asphaltic oil. These two materials function in a similar manner. Their proper use does not permit of application in sufficient quantities to entirely eliminate the dust, as this results in the formation of a surface crust which soon breaks up into holes and necessitates scarifying. If applied in smaller quantities at more frequent intervals, however, the dust may be reduced to a point where it is not objectionable and still leave enough loose gravel on the surface to be floated back and forth in patrol work. A uniform covering of ½ to 1 in. of loose material over the road surface before applying the dust layer is very desirable. Sections not having this cover are observed to glaze over and then break up into holes within a few weeks.

Practice in Use of Calcium Chloride.—Between 4,000 and 5,000 tons of calcium chloride are used annually in this state. The best practice is to apply from ¾ to 1 lb. per square yard for the first application and ¾ lb. per square yard for the second application, or perhaps make a second and third application of ½ lb. each, depending upon local conditions. A total of 2 lb. per square yard is usually ample to lay the dust for a period of 3 to 3½ months. The cost of this work ranges from $225 to $300 per mile for a season. In some sections of the state, traffic and local conditions are such that one application of about 1¼ lb. per square yard, placed on an 8-ft. strip in the middle of the road, renders it fairly dustless for the season. The chloride on this 8-ft. strip is worked to the edges of the road by traffic and patrol work, under this system the cost has been reduced to about $125 per mile.

Use of Light Asphaltic Oil.—Light asphaltic oil has not been used to any great extent in Michigan as a dust layer, it having been tried experimentally during the last three years. About 44 miles of road were treated in 1923. The oil used conformed to the state highway department's specifications for this material, and was applied by pressure distributor, without heating. The first application consists of 1/6 to 1/5 gal. per square yard and renders the road fairly dustless for a period of about 6 weeks, after which a second application of about ⅛ gal. per square yard is necessary. The relation between the quantity of oil applied and the amount of loose gravel on the road is important. The above quantities would apply to a surface having a uniform covering of about 1 in. of loose material.

Gravel Surface Prepared for Tar Treatment.

The most common error in oil treatment has been the use of too much oil in the second application, resulting in matting of the surface and subsequent roughness. The cost of two-application work in counties doing a rather small mileage has been about $400 per mile. One county, which is particularly well equipped for doing this type of work, made one application on 41 miles of road this year at an average cost of $132 per

mile. This was applied to a width of 12 ft.

Essentials for Use of Dust Layers.—Summarizing our experience with dust layers, we believe that the things most essential to their successful use are:

First: Proper control of the materials by specifications.

Second: The presence of a uniform covering of loose gravel on the road before treatment.

Third: Application in sufficiently small quantities to avoid solidifying the surface.

Spreading Pea Gravel on Second Coat of Tar.

As stated before, we have some 1,400 miles of trunk line gravel roads carrying a traffic of more than 600 vehicles per day and ranging in some cases to as high as 3,000 per day. There are, in addition, some county gravel roads having a daily traffic in excess of 600. The ultimate solution in case of the heavy traffic gravel road is, of course, to reconstruct with a permanent type of pavement. The time required to finance and build this large mileage of pavement will necessitate the maintenance of some heavily traveled gravel roads for a number of years.

Bituminous Surface Treatment on Gravel.—A partial solution of this maintenance problem may be found in the bituminous surface treatment on gravel, in the same manner as applied to macadam. We now have about 53 miles of this type of maintenance in the state. It cannot be successfully used on all kinds of gravel and should be attempted mainly on those roads containing a high percentage of stone, thoroughly compacted. The nearer this appoaches a macadam structure the better will be the results of treatment. A few of these roads received an initial treatment several years ago and have since been given lighter treatments. Twenty-six miles were given a first treatment in 1923.

The principles governing the surface treatment of gravel roads conform very closely to the established practice in surface treatment of water-bound macadam. In preparing the surface, sufficient blade work should be done to eliminate ruts and holes. This work may be continued to advantage, up to within two or three days of time of treatment, provided the gravel contains enough moisture to shape well. The surface is then thoroughly swept, removing all loose material and exposing the large stone. Particular attention should be given to cleaning the edges,

and traffic should not be permitted to use the road between the time of sweeping and treating.

Bituminous material is applied first as a prime coat at the rate of about 0.2 gal. per square yard, and allowed to penetrate for 24 hours or more. The second application is made in the amount of about 0.3 gal. per square yard, followed by a cover of stone or slag chips or pea gravel.

The hand maintenance which must follow this treatment is best conducted by mixing some of the same bituminous material used in the treatment with coarse sand. This is usually done with a small concrete mixer at a central location and the mixture is stocked in small piles along the road. Small surface breaks are easily repaired with this mixture. We have found that on gravel there is more tendency toward surface peeling, the first year, than there is on macadam. One man, equipped with a wheelbarrow and shovel can, under normal conditions, keep about 10 miles of road in good condition. This patrol work should be followed up consistently.

Costs.—The cost of maintenance of gravel surfaces having a daily traffic of more than 600, by the system of patrol graders, necessary resurfacing and dust palliatives, ranges upward from $600 per mile per year. A study of costs in a number of representative counties of the state would indicate that the relation between cost and traffic is, roughly, that the annual cost of this type of maintenance in dollars per mile equals the average daily traffic. That is, a daily traffic of 800 to 1,000 vehicles means an approximate annual maintenance cost of $800 to $1,000 per mile.

The cost of bituminous surface treatment is about $1,000 per mile for the first treatment and $750 per mile for subsequent lighter treatments. We have reason to believe that not more than three treatments will be required in a period of four years, which would bring the average annual cost of treatment down to about $625 per mile. In addition to the surface treatment, we have the patrol or hand-patching work, which will cost about $250 per mile, making a total annual cost of $875 per mile. This cost compares favorably with that of maintenance by the system of patrol graders, resurfacing and dust palliatives, for roads of 800 to 1,000 traffic. The bituminous treatment would probably be the cheaper method for roads of higher traffic.

Extreme frost action may necessitate scarifying and retreating some sections, but very little of this has been required on treatments of several years standing in this state. One or two failures of surface treatments on gravel have been partly due to lack of proper attention to details in placing the treatment, but largely due to the absence of patrol or patchwork, and these failures only serve to emphasize the importance of this latter phase of the work.

Aside from the consideration of cost, the bituminous surface treatment converts the gravel roads into a higher type. It provides absolute instead of partial elimination of dust, and produces a good driving surface, free from loose gravel. Treatments placed this year have been highly commended by the driving public and the owners of abutting property. Referring to the surface treated sections placed this year on trunk line 65, north of Ann Arbor, the Washtenaw County Road Commission, in their annual report, state that "no money ever spent for road maintenance in this county has given as much satisfaction to users of the road, as well as residents along the road."

The department feels that this type of maintenance, if properly handled, will provide a desirable intermediate step between the gravel surface and the pavement.

Protecting Whitewashed Poles from Porcupines and Groundhogs

Engineers in the employ of the Pennsylvania state highway department several years ago declared absence of the whitewash from telegraph poles a foot or two above the ground was due to the fondness of porcupines and groundhogs for the salt in the whitewash. The engineers experimented with different solutions in an effort to discover a whitewash these animals would not consider a delicacy; and it is now declared by Division Engineer J. S. Ritchey of Bloomsburg that the inclusion of lime sulphate in the whitewash puts the mixture in the poison class, so far as porcupines and groundhogs are concerned.

Design of Streets and Construction of Pavements

Present Practice of Cities Outlined in Report of Committee Upon Street and Sidewalk Design, Presented by E. R. Conant, Chairman, at Recent Convention of American Society for Municipal Improvements

Last year the committee presented considerable information, bearing upon the present practice followed by municipalities, as regards design of streets and construction of pavement, and it presents at this time some additional information along the same lines as last year.

Radii of Curb at Street and Lane Intersections.—That municipal and other engineers are recognizing the advantage gained with long radius corners is shown by the replies received to the questionnaire sent to many cities, which indicate that a decided reaction has set in of late, as regards adoption of the radii length.

Hartford, Conn., reports changing from 6 ft. to 12 ft. and 15 ft. and states a great improvement is noticeable with this change.

Waterloo, Ia., originally had 10 ft., a few years ago changed to 15 ft., is now adopting 30 ft. and this year changed some dozen street intersections to meet new requirements.

Toronto, Canada, had originally 12 ft., then changed to 18 ft. and now has adopted 25 ft.

Los Angeles reports that it uses a radius at curb returns equal to the width between the curb and property line, except where the distance on both streets is 15 ft. or greater. In such cases the radius is made 5 ft. greater than this distance.

At Muskogee, Okla., the narrower streets are given the greater radii; 24 to 30 ft. streets have radii at corners of 12 ft. to 15 ft., while for 30 ft. or over, a 10-ft. radius.

Pawtucket, R. I., is increasing radius from 15 to 25 ft.; Davenport, 10 to 15 ft.; Cheyenne, Wyo., new pavements 18 ft. Other cities report adopting radii of from 10 to 25 ft.

Elimination of Catchbasins.—The committee received many replies concerning catchbasin and inlet construction and finds that there is a decided tendency towards eliminating catchbasins and connecting the inlets direct to sewers or storm water conduits and especially is this done where there are adequate-sized storm sewers with good slopes.

The following cities report elimination, either complete or in progress: Quincy, Ill., Muskogee, Okla., Peoria, Kalamazoo, South Bend, St. Louis, Tulsa, Oklahoma City, Rockford, Shreveport, Long Beach, Houston, Cheyenne, Portland, Ore., Oakland, Colorado Springs, Berkeley, Sacramento, Boise City and Salt Lake City.

An unusual method of disposing of storm water drainage is reported from Phoenix, Ariz. No storm water sewers have been constructed and, to care for storm water disposal, wells 6 ft. internal diameter, are sunk to water bearing sand, usually 20 and sometimes 30 ft. below the surface. Brick is used for construction and within 6 ft. from the top it is of open construction and the bottom is left open. With proper inlets into the wells, it is reported that satisfactory results are attained, the water bearing sand taking away the discharge. The wells are expected to care for about 45,000 sq. ft. The diameter of inlet pipes to sewers are reported to range from 8 to 15 in.

Storm Water Inlets.—Information was sought as to size and type of inlets generally in use and replies received would indicate that some standardization of construction would be desirable. Grade of streets and character of surface, effecting run off, and amount of detritus carried, density of rainfall and minor local conditions, all bear upon the best method to follow for carrying away surface water.

One answer received, while humorous, yet speaks the truth. The engineer reports that he cannot see much advantage in the use of grates in the curb openings. Years ago, the openings in the gutters in this country were held down to small square openings, limited to the size of a calf's hoof. Of late years, calves are moved

by truck and some of these old grates will have to go.

Many cities report opening through curb only, others openings in gutters and in curbs. Many use rods, horizontal or vertical, or gratings in the curb openings. Others adopt clear openings from 6 to 8 in. in depth and of varying length. Openings into inlets are sometimes sunk an inch or so below curb grade and pavement sloped back to grade.

St. Louis standard inlets are 4½ ft. width in front and taper to 3 ft. 9 in. back, with depth of opening 6 in. and multiple of these are usual to meet variable conditions.

Approaches to Garage Driveways and Parking Places.—Present practice is generally to adopt a uniform slope from gutter or from curb sunk to within about 2 in. of gutter grade up to sidewalk through grass plot, if such exists, if not, a short ramp with steep slope of from 1 to 2 in. to the foot.

Two or three cities, Rockford, Muskogee, Jacksonville, Hartford, merge curb and gutter with rather long radius from the face and short radius for top of curb, and vehicles pass over the curb without serious trouble.

Chicago installs some catchbasins, adjoining raised crossings to care for drainage flow and constant aprons, running back from top of curb, with grade of ½ in. to the foot.

Richmond, Ind., Pontiac, Mich., Oklahoma City, Boise, Idaho, and Indianapolis, report constructing a gutter a few feet out from curb and constructing crossing ramp from this gutter to curb.

Special Curb and Gutter Construction.—An innovation as to the cross section of curb is being introduced, which appears practical and beneficial. We all know that automobile and truck tires are often injured by grinding against the vertical rough stone curb and a few cities are adopting a curb with a batter on the gutter side and again this batter is sometimes merged with the gutter and the gutter and curb formed with a curved face.

Jacksonville, Fla., Shreveport, La., Salt Lake City, Phoenix, Ariz., Sacramento and Hartford, are introducing this method to a greater or less extent.

Quite a number of cities, where they have bituminous type of pavements, are introducing a gutter of frame 4½ to 6 ft. wide, built of concrete brick or hard surface, which would not be affected by gasoline or oil drippings from automobiles or trucks. Boise, Idaho, Muskogee, Sacramento and St. Louis report this improvement.

Sidewalk Design.—Some additional information was obtained as regards sidewalk widths, generally adopted, and means of relieving congested foot traffic.

San Francisco is constructing underpasses for pedestrian traffic at major boulevard intersections.

A few replies received report fixed widths of sidewalks for varying street widths.

Oakland, Cal., reports for:

40 ft. street, 8 ft. sidewalk.
50 ft. street, 10 ft. sidewalk.
60 ft. street, 14 ft. sidewalk.
80 ft. street, 18 ft. sidewalk.
100 ft. street, 20 ft. sidewalk.

San Francisco reports:

40- 50 ft. street, 10 ft. sidewalk.
50- 60 ft. street, 13 ft. sidewalk.
60- 70 ft. street, 15 ft. sidewalk.
70- 80 ft. street, 18 ft. sidewalk.
80-100 ft. street, 19 ft. sidewalk.
100 or over street, 22 ft. sidewalk.

Streets less than 40 ft., sidewalk width one-fifth of street width.

Brookline, Mass., allots one-sixth of the width of the street in business sections where widths do not exceed 60 ft. to sidewalk space.

From 20 answers to the inquiry as regards width of sidewalk, we note the average width, for residential streets, to be from 4½ to 6 ft. and for business thoroughfares, a varying width from 14 to 25 ft. Shreveport reports that 40 per cent of street width has to be allotted to sidewalk.

Special Features of Design.—Oak Park reports removal of grass plots in the center of certain thoroughfares, for parking places.

St. Louis has adopted additional parking space by surrounding certain areas in wide streets with curbing 2 in. high, over which autos to park can readily pass.

Brookline, Mass., has taken away a portion of the space formerly allotted for a bridle path and uses same for parking space.

Boise City allots a width of 16 ft. for parking in the center of a 100-ft. boulevard. Salt Lake City uses a strip bordering the street railway tracks for parking cars. Rockford,

Ill., is designing streets with parkway in center.

In some cities, there are commons or small parks, with sidewalks outside of same. These sidewalks could be transferred inside the commons and space used for parking. But, to do this, State Legislature is usually required. It would appear that individual treatment has to be given for each case and every effort must be made to relieve existing conditions in many cities for care of cars.

Pavement Construction. — In the past year, two features are outstanding, which will result in economy as regards street construction.

The Department of Commerce has recently announced that the new standard for asphalt grading (as determined by penetration limits) becomes effective January 1, 1924. Hereafter, instead of 50 or 100 grades, the new standard will comprise 10. This follows earnest work done by the producers and consumers, and it now behooves asphalt users to see that their specifications adhere to the adopted grades, the ranges for which, as regards penetration limits, is sufficient to provide for all reasonable requirements.

New standards for establishing sizes of brick were also consummated the past year, and instead of 66 varieties in use before standardization took place, there are now but 6.

The penetration limits for asphalt used in asphaltic pavements is being decidedly reduced, according to information received from a large number of cities. Also quite a few report using additional amount of dust. The changes bring about a harder mixture and one that prevents pushing and shoving under traffic.

Penetration Limits for Asphalt.—St. Louis, Chicago, Wichita, Oak Park, report the penetration used from 30 to 40 for heavy traffic streets; from 40 to 50 for lighter traffic; and a number report using a lower penetration, without stating limits.

St. Louis, in addition to lowering the penetraton limit, has increased the amount of material retained on a No. 40 sieve. The mix used in refined asphalt wearing surface being:

Retained on No. 10 mesh sieve, 8%.
Retained on No. 40 mesh sieve, 34%.
Retained on No. 80 mesh sieve, 25%.
Retained on No. 200 mesh sieve, 10%.
Passing 200 mesh sieve, 14%.
Bitumen, 9%.

Experience with this mix is reported to give a close compact surface, which irons out well and does not push or become wavy under traffic.

Concrete Base Thickness.—Information received from many engineers show that they are increasing the concrete base thickness and, in some instances, increasing the thickness of the wearing surface.

Peoria, Wichita, Davenport, Oak Park, St. Louis, Tulsa, Sioux City, Pontiac, Oklahoma City and New Orleans, report increase of depth of base of about 1 in. The average adopted for heavy traffic being from 7 to 9 in.; medium, 6 to 7 in.; light, 5 to 6 in.

Indianapolis reports that the concrete base laid in the city shall be roughened by an approved roughening device.

Muskogee, Okla., requires a compression test of its concrete pavements, within a given period. Samples are taken from the pavement and, if the required test is not met, removal of the rejected section is required. If it runs 80 per cent of the strength required, it may remain in place and be accepted, the city preserving, however, 20 to 50 per cent of the contract price for the yardage in question until the end of the payment period. In addition, the city is protected by the maintenance bond.

Burning Leaves on Roads Damages Surfaces

As a result of several instances of damage to the surface of public highways through the burning of leaves on the roads, officers of the Connecticut state police department patrolling the state were instructed to put a stop to the practice. Highway Commissioner John A. Macdonald, in a communication to the superintendent of the state police department, pointed out that the highways are mostly treated with asphalt, tar or some carbohydrate which contains volatile oils, easily ignited. It has been ascertained that any fire or heat applied to the highways, especially fires of leaves, which produce as hot a fire as it is possible to obtain is very disastrous to the roads. The leaf fires are dangerous in view of the fact that the ashes serve as a mat and hold heat for a long time.

The Lighting of Streets and Highways

Principles and Practice Outlined in Paper Presented Nov. 13 at Annual Convention of American Society for Municipal Improvements

By STEPHEN CARLETON ROGERS

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Vision is accomplished in two ways, or in a combination of two ways. Objects, persons, etc., are seen either in silhouette against the lighted background of the street surface or else by the direct light from the lamps themselves. When objects are seen in silhouette, their bulk or outline is observed; when objects are seen in perspective, or by direct light, their details or features are distinguished. All objects, etc., therefore, whether by day or by night, must be seen either in silhouette or in perspective or by a combination of the two. These principles should be remembered, as street lighting, to a very large degree, depends upon them, no matter what class of street lighting is being considered. Vision by silhouette has been known and recognized by artists for many years, but has been appreciated by the illuminating engineer for only a comparatively short time.

Depending upon these two methods of vision are the two main types of street lighting, which may be classified as follows:

1. Large unit lighting.
2. Small unit lighting.

Large Unit Lighting.—If a large unit equipped with a diffusing globe, for example, either a 6.6 ampere luminous (magnetite) arc lamp or a 15,000 lumen incandescent (Mazda C) lamp be placed on the side of a street some distance away as, for instance, 300 ft., objects, persons, etc., will be seen more in silhouette than in perspective. This is commonly termed "large unit street lighting," and the illumination will be of a maximum high intensity and from a concentrated light source. It is clear, therefore, that whenever large unit lighting is employed that silhouetting will be more generally used, particularly so when the lighting units are spaced quite a distance apart. The closer the units be spaced, the more will perspective vision occur in conjunction, of course, with silhouette vision. The diffusing globe will cut down the candlepower of either of the large units just mentioned to about 960. If, for instance, 12 80 c. p. incandescent lamps be grouped together and placed in a single large globe, the resultant illumination would be practically the same as with the use of the single large unit.

Small Unit Lighting. — Suppose, however, that these 12 small 80 c. p. incandescent lamps be distributed along the same street and uniformly spaced. The result then would be known as "small unit street lighting," the illumination will be fairly uniform but of low intensity and from distributed light sources. With this type of street lighting there will not be enough intensity for either silhouette or good perspective vision. These two distinct types of street lighting also produce entirely different psychological effects, as was shown during some street lighting tests conducted a few years ago, where it was shown that large unit lighting is by far the superior and more essential for good street lighting from every angle.

There is still a very important phase that should be considered—viz., the status of large units versus small units, viewed from an economic point of view. A city or town naturally, since it is the party that has to pay the bills, is most vitally interested in street lighting and its costs. Since many cities have a certain appropriation for street lighting, they usually want to know what type of lighting will give the best results for that given amount of money, rather than what is the best street lighting it can get and then how much will it cost. According to prevailing conditions and rates it will cost a city approximately $100 per year for each large unit and about $25 per year for each small unit, considering these sizes just referred to. This will mean something like 3 large units for every 12 small units, or roughly, three times the total light flux with its accompanying increased illumination and

better visual effect for the same total cost per year.

Street Lighting Practice.—Street lighting in general may be divided into the following five classes:

Class I. Main business streets—highly intensive or white way illumination.

Class II. Secondary business streets—good general illumination.

Class III. Boulevards and main residential thoroughfares.

Class IV. Side residential streets—comparatively low illumination.

Class V. Interurban or main automobile highways.

Class I. Main business streets.

Main Business Street Lighting.—The main business streets of a large city may be properly separated into two subdivisions, whereas, in a smaller city this distinction is lacking—it being hard to tell where one type stops and the other starts.

(a) Streets, whose stores are essentially retail and depend largely upon show windows for the display of their goods, merchandise or wares—streets that are of greatest distinction.

(b) Important business streets largely traveled at night.

The type of lighting that should be employed should be such as to satisfy every requirement of police protection, the motorist, the safety of the pedestrian, the merchant, the aesthetic sense, etc.

In order to accomplish this result, the illumination of the street surface must be of high intensity so that silhouette, together with perspective vision may be employed; cornices, facades and other architectural details and effects must be brought out. In order to achieve these desired results, lighting units of high candlepower closely spaced must be used, the units themselves must be attractive by day as well as by night, and they should be mounted upon ornamental standards, thereby doing away with unsightly overhead wires and trolley poles, etc. In large cities, two and three of these large units per post, equipped with diffusing glassware, should be specified with approximately 100-ft. spacing per side at 20-30-ft. heights. In cities of this type the buildings range from six stories and upwards, so that a light distribution with nearly equal amount of light in upper and lower hemisphere should be used. By the use of the new alabaster rippled glassware, the most pleasing effects are produced. In the small cities, where the buildings are rarely four to six stories high, excellent results may be obtained by the use of single lamp standards 15 to 18 ft. high, and when using the incandescent lamp the dome refractor and light alabaster rippled globe may be used, as this particular combination has been designed so as to permit the illumination of building fronts of comparatively few stories height and at the same time considerably increase the illumination of the street surface. On the other hand, suppose that a type of distribution should be used which has practically no light in the upper hemisphere, such as would be obtained from a unit with clear globe and reflector or ordinary refractor installation (not the dome refractor and rippled globes), what would be the result? There would be a sharp shadow, a sharp cut off on the building fronts, which would give a very uunpleasant effect—absolutely wrong physiologically as well psychologically.

There is yet another factor that enters into lighting of this class—viz., the quality of light. The chief difference between the magnetite arc lamp and the incandescent lamp of equal intensity is the color. The color of the luminous (magnetite) arc lamp is the nearest approach to daylight of any artificial illuminant commercially exploited. This white color of the magnetite arc is considered by many to be unexcelled for certain classes of lighting—especially the high intensive class where there is show window lighting. In order to get the most effective show window lighting a soft warm lighting effect is most desirable, which is obtained when the ordinary incandescent lamp is used. When the streets are lighted, the effectiveness of the show window is greatly decreased, if the color of the street lighting is the same as that of the show window lighting, because contrast will be lacking. However, if the streets are lighted with the white color of the magnetite arc lamp then the show windows will be in contrast with their warmer yellow light, and the attractiveness of the windows will increase and they

will stand out in most beautiful fashion. This, in fact, is the accepted standard among those who are doing the highest grade intensive lighting today.

What would be the result if the windows should be lighted with white light (thereby revealing correct color values) and the street lighted with yellowish light? The contrast will be in the wrong direction, for the background will be cold and harsh and the foreground warm, whereas, the background must be warm and the foreground cold to satisfy. The revealing power, that is, the ability to pick up objects, etc., with white light is greater than with yellow light.

Types of Refractors.—It may be pertinent here to describe some of the various types of refractors in use, and show why only the dome refractor is suitable for this class of lighting. The original refractor consisted of a series of horizontal prisms, both above and below the light source so as to redirect all of the light flux both upward and downward at a predetermined angle in the hopes of approaching a uniform horizontal illumination. This principle is, of course, fundamentally wrong, since non-uniform illumination is of far more use in street lighting illumination. It was found that fairly good street illumination could be obtained by leaving off the prisms in the lower hemisphere thereby not altering the downward direct light, but adding to the downward light at a given angle a large part of the upward light. In both of these refractors there is an external piece consisting of a series of vertical prisms so as to diffuse the light and lower the brilliancy, thus reducing the glare. If now either of these refractors is put into an ordinary diffusing globe the refractive feature will be lost and the resultant illumination will be less than is obtained by leaving off the refractor.

In the case of the dome refractor, however, there are no vertical prisms; two separate series of horizontal prisms in the upper hemisphere being used to redirect the upward light, thereby utilizing a larger spherical angle and a consequently greater amount of light flux. In order to reduce glare, a rippled glass globe is used which, when very lightly coated with alabaster, does not entirely nullify the directive feature of the refractor and at the same time spreads sufficient light upward for fairly high buildings. The asymmetric type of refractor, of course, takes even more light from the building fronts and should be used only for other classes of streets as described later.

Lighting of Secondary Business Streets.—This classification should include those business streets not coming under Class I, in other words, those having comparatively little travel at night, those including largely wholesale stores, warehouses, factories, etc. In streets of this class the same type of illuminant should be used, the same intensity of unit, but longer spacing between lamps than in Class I. This is more advisable than going to the next smaller size unit and retaining the same spacing, although the cost per year may be the same, better visual effects may be obtained by fewer larger units than by more smaller units. The lighting of these streets is mostly done for police and fire protection.

Boulevards and Main Residential Thoroughfares Lighting. — In this classification should also be included park lighting. These streets are used by automobilists and pedestrians, and the needs of each should be satisfied. Lamps best suited for this type of lighting should be of the ornamental types used for Classes I and II lighting, but spaced farther apart. Of course, the best results will be obtained by using the large 6.6 amp. luminous arc lamps or the 15000 lumen incandescent lamps—however, very fine results can be obtained with the 4 or 5 amp. luminous arc lamps or the 6000 or 10000 lumen incandescent lamps with rippled globes. It might be added that a semi-ornamental bracket type of unit giving the same light distribution can be used where overhead wiring is available, thereby saving the additional expense of ornamental standards and underground wiring.

Lighting Side Residential Streets.—On account of the small amount of motor travel on this type of street, a less expensive unit can be well utilized here, one employing a 4000 lumen incandescent lamp serving the purpose admirably. A novel as well as utilitarian unit has recently been designed for this work. It consists of

a single piece glazed porcelain which acts as insulator and prismatic glass holder as well.

Interurban or Main Automobile Highway Lighting.—These roads are the main traffic routes connecting towns and cities. The problem of lighting these is entirely changed, due to the ever increasing auto traffic and headlight glare. Another factor enters into this class of lighting especially, namely the character of the road surface. There are for all practical purposes three main types of road surfaces:

1. Non-reflecting, non-diffusing—viz., country roads with possibly a light coating of oil to lay the dust.

2. Diffusing—light dust, reinforced concrete, cement roads.

3. Reflecting—bituminous macadam, asphalt, wood block, etc., roads.

The majority of these highways are of the latter two types with the reflecting types in greater abundance. Because of these improved roads, it has been possible to design and utilize a special unit, consisting of a number of nested parabolic reflectors, making it possible for one lamp to be in the focus of six reflectors and thereby distributing the light along the road without any spilled or wasted light, as is the case with other than asymmetric distribution of light. In the case of the black surface roads, it is possible using 2,500 lumen (250 c-p.) lamps with spacing of 300 ft. and height of 30 ft. to make the road surface a veritable ribbon of light—to use the road surface as a secondary light source—to reduce glare from approaching automobile headlights by decreasing the contrast between them and their background. This type of lighting is one of the greatest advances in street illumination that has been made—it is very economical, especially when it is considered that it costs approximately $30,000 to $40,000 per mile for investment of the road itself as against $3,000 per mile for the lighting units and lines, etc., maintenance of the roads costs about $5,000 per mile, as against $1,000 per mile for the lighting. Some of the obvious advantages of this kind of lighting are as follows:

I. Prevent accidents

1. By showing up dangerous curves.

2. By reducing headlight glare.

3. By illuminating signs, sides of roads, and obstacles.

II. Adds to comfort of night driving

1. By relieving eye strain.

2. By assisting in making repairs.

3. By discouraging holdups.

III. Increases night traffic and thereby relieves day congestion.

IV. Decreases running time and increases road capacity.

V. Helps to bring electricity to the farm by providing a pole line.

VI. Increases real estate values

1. By tending to extend the city along highways.

2. By bringing electrical conveniences.

As an illustration of what might be accomplished in the way of highway lighting from an economic point of view, take, for example, Massachusetts (and the same might apply to any other state). There are at present, roughly 1,500 miles of improved state highway, which should be scientifically lighted. This would mean an initial investment of about $5,000,000, with a yearly maintenance cost of $1,500,000 (figuring an average cost of $60 per lamp year to the city or state). A few years ago drastic headlight laws were enacted, which it has been conservatively estimated, cost the automobile owners more than $2,500,000 at that time, plus the additional amount necessary for their upkeep. If this money had been expended in the proper direction, headlights would be unecessary and safety to all would have been increased.

Road Mileage of Missouri.—According to figures of the U. S. Bureau of Public Roads, Missouri now has 46,311 miles of improved road, not including that added during last season. The total road mileage of the state is 111,521, as compared with 96,041 miles in 1914, and during the 7-year period from 1914 the surfaced and paved roads have increased from 6,713 to 7,880 miles. The total highway income in 1921 amounted to $16,494,975, or $240 for each square mile of area, $148 for each mile of road, or $4.85 per capita.

Road Service in Industrial Regions

A Paper Presented at the Richmond Convention of the American Society of Civil Engineers

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Service is defined as the performance of labor for the benefit of another, or that which promotes interest or happiness. When applied to roads, there is also implied a continuity and not a single action.

Road service to be of greatest benefit must be applicable to the pleasure car as well as to the commercial truck. In planning this service, both of these factors must be taken into consideration in the road design. There is also to be considered the demand which requires the continuity of the service in certain locations for 24-hour period during all the days of the year.

Road service means not alone the taking care of present requirements, but foreseeing future needs so that additional service may be furnished when required. No data is available which will determine this need or from which the curves of natural increase can be computed.

The demand for service has increased far beyond the power of the average municipality or state to meet. In number of vehicles, weight of loads and length of trips, no estimate made even the short period of five years ago has been equalled in the actuality. The curve of increase of these factors is not a straight line, but takes the form of a parabola of undetermined dimension.

Factors in Selecting Road Surface.—In deciding upon the character of road surface several important factors must be taken into account; namely, regular movement of long hauls, regular movement of short hauls, and irregular movement, which may be also seasonal in character. The road design will necessarily include the combining of these various demands so that all classes of traffic will be reasonably and safely carried at all times. This implies continuity of service even under extreme conditions of weather, these conditions being anticipated rather than taken care of as the occasion arises.

These factors must be considered when designing a road for estimated as well as actual traffic, and determine nature and width of surface as well as alignment and grade.

Safety Precautions for Traffic.—The

View at Fairfield, Conn., Showing White Line on Pavement for Dividing and Directing Traffic.

design must also include the necessary safety precautions for the rapid and safe operation of all classes of traffic, from the heaviest loaded truck to the fastest passenger car.

Under this head would come the opening up of sight lines, the widening and banking of curves, the relieving of narrow conditions which slow traffic and restrict free movement over the entire highway, and the posting of all danger points with conspicuous signs, visible by night as well as by day, so as nearly as possible to automatically control the safe driving speed over any section of highway.

One of the causes for slowing up of traffic is the lack of a marker which properly defines the highway to the occasional user. A system should be installed which will clearly and accurately define the road over which it is desired to proceed, so that the driver will clearly see such markers without taking his attention from the car operation or require him to give more than a casual glance to accurately define his route. One has only to note the number of vehicles held at the opening of a draw bridge, possibly for a 3-minute interval, on a heavily congested highway to realize that the slowing up of traffic by any circumstance which can be avoided cuts down the capacity of the road to an extent which, without actual count, can hardly be comprehended.

New England Trunk Line Numbering System.—The New England states have adopted a numerical system of designating trunk line through highways. Each state, through a joint committee of members of the state highway departments, the New England hotel men's association and automobile clubs, met at Boston and laid out the main traveled trunk line highways in accordance with the general direction of travel. Each of these highways was given a designated number and each state highway department posts this number within its boundaries. Connecting and secondary roads are designated with numbers above 100, each carrying the name of the state in addition to the number. Care has been taken where one of these connecting routes crosses a state line that the same number shall be used in the adjoining state. Maps have been issued for the tourist, and the numbers have been placed in most of the states this season.

It is hoped that the system will prove of advantage over the separate state markers now generally in use, so that the demand for extension to other territories will eventually result in long, continuous marked highways from coast to coast and from lakes to gulf.

Only 1 Per Cent Use Highways Improperly or Illegally.—The policing of the highways in order to properly maintain reasonable speed and free movement is a question which should be considered as well as actual construction of the highway. The road is only of value, no matter what its condition, in so far as free movement thereon is permitted. The improper or illegal use of highways is probably much less than 1 per cent. All operators, however, must be compelled to properly respect the rights of others, and only a competent policing force with accurate knowledge of road conditions, needs and speed values will be able to handle traffic satisfactorily. Such officers may be of inestimable aid in anticipating possible congestion and making preparations therefor, and by their judgment and decision, with the necessary previous practical training, may increase the capacity of any road to a large extent.

Much attention has been paid in the past to the fast driver, and many of the serious and fatal accidents occurring daily can be charged to his account. On many highways, however, this class of traffic is far less dangerous from an accident point of view than the operation of the slow driver who holds the traffic below a reasonable speed. With havy opposing traffic, little opportunity is offered to pass the slow moving vehicle in front. Eventually, as vehicle after vehicle slows down in the line, some driver takes an estimated opportunity to pass. The result is often a collision or the assumption of rights properly belonging to the opposing driver.

It is believed that more attention should be paid to the slow moving vehicle, and that the operator should either be denied the use of the highway during the congested hours or delegated to the secondary road, where his operations will not seriously decrease the capacity of the highway or affect the rights of others.

The Short Time Census.—Many organizations have at various times taken censuses for short periods of time, but these, as a whole, have been of a general type, determining only the number of vehicles passing a given point during a given time. Such a census is of value only in a broad sense and does not aid in determining many of the questions in modern road design and construction. With additional observers, and carried on for a longer period of time so as to determine seasonal variation of traffic and commodities, much additional data can be obtained from which the needs of any particular locality can be approximately determined. In farming localities the movement of traffic is necessarily seasonal, the roads being called upon to carry the larger percentage of their capacity during the season when weather conditions are most favorable. This is also true of touring traffic.

In addition to these classes comes the business traffic, for which provision must be made during the entire year, and the industrial traffic, which, while somewhat seasonal, due to the character of the manufactured materials, is largely constant during the entire year in many industrial communitiès.

The Connecticut Traffic Census.—The Connecticut traffic census, conducted in co-operation with the Bureau of Public Roads, has just been completed, after a full year's operation. The amount of detail collected has been very large, and this is being tabulated in the Office of Public Roads in Washington. The census covers practically every phase of transportation, including distance, commodity, overloading, tire widths, distribution of load, type of vehicle, and many other details.

Winter Road in Windham County, Connecticut.

A traffic survey does not necessarily determine where new construction is to be placed unless factors other than the volume and weight of traffic are taken into consideration. If construction is planned only where the amount

of traffic is the heaviest, very few of the feeder roads will obtain any state aid.

The function of road building is not alone the taking care of present and potential traffic, but the development of the entire state as a whole. The plan must include the care of the outlying districts, so that the necessity of any community may enter into the road construction program. No traffic survey will determine the location of new traffic lines which may be opened by a connecting link of new construction. There must be considered the increase in traffic due to the natural growth of motor transportation, which can only be roughly determined after years of obtained data.

What the Connecticut Census Shows. The preliminary report for the first three months of the Connecticut traffic census has developed data which in many cases has revolutionized the preconceived estimate of conditions. The increase in highway cost, both of construction and maintenance, is largely offset by the increase in the number of vehicles. It is believed that the operating cost per vehicle will be no greater if the proper percentage of such cost is assessed against that vehicle; that is, if the reduced expense of operation due to improved highways is transferred to the fees for registration, and such fees are utilized for new construction and maintenance of the highway system.

The completed census report, among other items, will cover a determination of regular and irregular truck movement and its relation to other transportation systems, a study of the passenger service as to business or non-business movement, and its competition with other forms of transportation, and the type of service required on any particular highway as to volume, speed and character.

Normal Winter Condition of Trunk Line Highway in Washington, Conn.

In the analysis of the first three months the average number of passengers per pleasure vehicle was 2.5 for a distance of 45.1 miles. Of this 35 per cent was business traffic and 65 per cent non-business, the business mileage amounting to 29.7 miles per car and the non-business mileage to 55.5 miles per car. If this passenger traffic is analyzed on a mileage basis, 23.5 per cent is business traffic and 76.5 non-business traffic. It would

therefore appear that this is largely a non-business, non-competitive usage.

In truck capacities 44.1 per cent of all trucks are under 1½ tons and 22 per cent of 5 tons or over. From previous determination, it would appear that the number of large truck capacities is gradually diminishing on the highways.

In regard to the usage of the state highways by foreign trucks, the census shows that 89 per cent of all trucks are operating with Connecticut registration, carrying 86.5 per cent of the total net tonnage, while 11 per cent are of foreign registration, carrying 13.5 per cent of the total net tonnage. If this is transferred to a mileage basis, Connecticut trucks transport commodities 65.2 per cent of the mileage, while foreign trucks are accountable for 34.8 per cent of the mileage. An account of the loaded or empty trucks show that approximately two-thirds of the operating trucks are loaded and one-third empty. It is fair to assume, therefore, that the return load problem has not been worked out to its greatest advantage by the truck operator. Comparison of length of haul shows that 36.9 per cent of the total tonnage is transported from 1 to 9 miles, 30.5 per cent from 10 to 29 miles, and 32.6 per cent for a distance of 30 miles or over. Transportation by truck, therefore, is only partially competitive and would apply only to certain articles in which the cost of packing or the quick delivery plays an important part. It is probable that on long hauls the truck cannot compete with the railroad, even though two loading and unloading charges are absorbed by the truck delivery.

On a commodity basis, it has been been determined that 81.5 per cent of commodities transported originate in Connecticut and 18.5 per cent in other state, showing that the road service rendered is largely for Connecticut itself.

Mr. McKay comments as follows on the general situation: "In general the analysis of motor truck transportation in the New England area indicates that the bulk of the tonnage is a non-competitive short haul transportation of freight from the manufacturer's point of view.

"With a permanent improvement in rail service, a considerable portion of the long haul motor truck freight will be shipped by rail.

"The return load business is an important factor in rate making, and as a general practice in New England, the rates charged for return loads are lower than rates for outbound freight, on the theory that a small profit on the return load is more profitable than to return empty. The result of this practice is to lower the level of rates charged for outbound business."

Saturation Point Reduced on Eastern Highways.—It has already been suggested that on the heavily traveled thoroughfares of the eastern seaboard the point of saturation has been reached, and the only solution is the widening of the thoroughfares at an almost prohibitive cost, due to property damage, or the construction of parallel roads, which to a large extent will enter the outskirts of the cities only. Where such conditions exist we may expect, within the next few years, practically new layouts of trunk line roads, through undeveloped sections as far as possible, with minimum grade and curvature and adapted to the fastest traffic consistent with safety.

The design of such roads will eliminate the grade crossing of trunk line highways of similar class, as well as make proper provision for the constant policing and dispatching of vehicle trains. If this statement seems a visionary one, think of the conditions 5 years ago as compared with those today. Can any of us estimate even roughly what traffic will demand 5 years hence?

Snow Removal on Main Highways.—Continuity of service is demanded and must be furnished. In the northern sections of the country, where winter conditions are extreme, the removal of snow from the main highways will be demanded. It is impracticable to purchase and maintain enough snow fighting equipment to take care of the most extreme weather conditions on account of the excessive cost. Arrangements, therefore, must be made to control a sufficient quantity of this equipment for average or more than average conditions, and to utilize during the heavier snow falls additional equipment which can be hired in each locality. Where plows attached to trucks are used, it has been found

that under normal conditions one truck will be able to open in a reasonable time about 10 miles of highway.

During a storm efforts should be made to keep in use only a two-path track. With clear weather, however, widening should begin and the snow pushed back as far as possible, so as to furnish the room which may be required for placing additional snow.

traffic. After this is accomplished, all feeder lines and secondary roads should be cleared. Much of the value of the long distance trucking depends upon continuous service, and it is only in this way that public demands will be met.

Road service is public service, and those to whom this has been entrusted must consider that in furnishing and anticipating such service, the advan-

Drift in 1923 on Trunk Line Highway in New Milford, Conn.

It is in this class of work that the personnal of any department shows to the greatest advantage. It is sometimes necessary, due to isolated conditions or continuous snow fall, to require the men on the snow fighting equipment to operate for long continued periods in order that the necessary work to be accomplished. Additional men to replace as far as possible the regular force should be provided, but it is rarely possible under ordinary labor conditions to keep in demand a force of men either with the necessary knowledge or stamina to operate the snow fighting equipment. The equipment should be capable of opening all main traveled trunk lines, within 24 hours after the fall of snow has ceased, to two-way

tage accrues not only to the operator, the owner, or the producer, but the entire community at large.

Center Lining Minnesota Highways

Center lines are being painted on the 416 miles of paving on the Minnesota trunk highways system. A special machine has been built at the state highway department shops to paint the strips on the pavements. A 4-in. rubber tire on a small wheel puts a stripe of like width in the exact center of the pavement as other wheels guide the truck on which the machine is mounted. The outfit is expected to average 25 miles of paving a day and soon will cover all hard-surfaced sections of the system.

Penetration and Surface Treated Macadam Roads

Method of Construction and Maintenance in Marquette County, Mich., Described in Paper Presented Nov. 7 at Annual Convention of Michigan State Good Roads Association

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At the time the volume of motor traffic began to advance with the rapidity with which you are all familiar, some eight years ago, our district contained a considerable number of water bound macadam roads. In all instances in Marquette County the roads were built of trap rock, granite or quartzite. Our trap rocks are excellent for wear resistance, but the cementing quality in water binding is usually below that of a lime rock, whereas the granite or quartzite stretches were usually bound with clay and stone dust mixed, the rock powder from these latter rocks having a cementing value of practically nil. We had very little granite or quartz rock macadam.

The First Surface Treated Road.—This traffic, which raveled the plain water bound road, coupled with the financial necessity of using our roads as long as they could be made to give reasonable service, induced us to turn to surface treatment of these roads. The first stretch worked in this way was the road between the cities of Negaunee and Marquette. This road was reconditioned under traffic in the years 1916 and 1917, the work really being in the nature of a light water bound resurfacing, and the road was treated, as fast as it was put in shape, with a surface treatment of refined tar at the rate of ½ gal. to the square yard. The cover used on the tar was washed pebble passing a ⅝ in. screen from a pit which contained chiefly granite pebble or ¾ in. rock chips with all dust removed. The cover was applied at a rate of approximately 70 tons per mile. The width of the treatment was 15 ft.

The following year a second surface treatment was made on this road, using ¼ gal. of tar to the square yard, and approximately the same amount of chips or pea gravel, as during the first application. All of this road had received its second treatment by mid-summer of 1918, and has not had a re-treatment since that date.

Maintenance and Traffic on the Road.—Maintenance has been of the continuous patrol type. To supply the patrolman with materials, barrels of tar are buried into the road slopes or sides at convenient places, and frequent piles of cover gravel are stocked upon the shoulders.

The maintenance of this section, which is approximately 8 miles in length, is handled by one patrolman. He is given extra help immediately following the spring break-up so as to quickly patch up the entire length of the road, and at the same time shoulders are built up, any cold patch work required is done, and then for the balance of the year the road is kept up by one man. Paint patch methods are followed.

This road has now been in use more than 5 years since its last surface treatment, and under traffic varying from 800 to 2,500 vehicles per day. It is expected to give this road a ¼ gal. treatment next year. The surface of the road is in very good shape with the exception of a few short stretches where foundation troubles are manifesting themselves on the surface in cracks or settlement which has required cold patching.

Mileage of Surface Treated Roads.—I have gone into detail purposely upon this one section because it was our first stretch, and because our present practice in handling this work was developed upon it. We follow substantially the same line of operation upon all of the surface treated roads, and we now have of this surface treatment type in use the following roads:

Old macadam reconditioned and surface treated with tar	17 miles
Class C—gravel macadam, tar treatment	3 miles
Class B—gravel, tar treatment	3 miles
Rubble base course, hot asphalt treatment	4 miles
Rubble base course, tar treatment	11 miles
Total	38 miles

Not including work done in the cities.

This latter type, or rubble base course, is a special specification road

in which a heavy bed, usually a foot thick, of waste mine or cheap quarry rock is built and smoothed up, expecting this to be the bottom course of a penetration road in the future, but which is to be used as a 1-course road for the present, and is surface treated for that purpose. The object of this type of construction being to get more miles of road immediately usable from the same amount of money. Using the bottom course as a road also delays the period of the first resurfacing of the finished road and develops the traffic requirements prior to building of the completed road.

Comments on Surface Treatments.—Commenting on surface treatments, I believe it is proper to emphasize first and all the time, the importance of cleanliness. This is not a new treatment, but it simply cannot be over-advocated. The hot surface treatment seems to require approximately twice as much cover material as we usually put on the cold treatments, but in this connection I should call attention to the fact that I am a believer in using the very minimum of cover material which it is practicable to use and accomplish the object of the treatment. Our cold treatments are always heated to around 100° F.

I do not believe that a surface treatment should be made with the idea that it will recondition a wornout macadam road. The road should be reconditioned first. A surface treatment in final analysis is a painting proposition and it is primarily preservative in its operation, with the added advantage of abating the dust nuisance.

Construction of Penetration Type.—Penetration roads are not new in road building and no mention need here be made of the methods of construction. We have only been building them on the country roads for about 3 years in our district, but I have personal knowledge of several stretches under city traffic which are 8 to 10 years old which are in perfect shape, and have had very little maintenance other than cleaning.

When it became necessary to rebuild a 6-mile piece of old macadam road on M 15, south of Marquette, an inspection showed that traffic could be diverted from the road by detours. The available rock was suitable for any of the usual types of road, but the best available rock was a quartzite, unsuitable for water bound macadam, and it appeared that to reconstruct this road as a water bonded road would cost substantially as much as to build a penetration top. It might be pointed out that in these two types of construction, i. e., surface treated, water bounded or penetration macadam, the penetration bitumen with keystone and chips takes the place of the dust, water bounding and surface treatment, and that otherwise costs usually remain nearly the same, so that when traffic can be detoured, a penetration road is usually preferable to a water bound surface treated roadway, both as to ultimate economy and as to service.

For these reasons the old macadam on this M 15 was shaped up and widened to form a base course and a 3 in. penetration macadam top built upon it. The road has gone through 3 years of heavy and mixed traffic with practically no repairs to the traveled way, and only the usual shoulder, ditch and roadside maintenance. The maintenance being of the continuous patrol type, one man working full time upon the section which comprises the entire 6-mile stretch. Most of the work has been upon the shoulders, as this is a light soil district and the grass is only now starting to give much protection from erosion of the slopes and shoulders.

We also have 8¼ miles of penetration macadam on M 15 west of Ishpeming, and 2 miles on one of the county trunk highways connecting one of the larger mining towns with the state trunk highway. Both are very satisfactory roads, built with a mine rock lower course and quartzite rock tar penetration tops.

Concerning the construction of macadam roads, there is one feature of the specifications of our state highway department with which I am not in accord. As I read their general specifications, any of the macadam types of road may be built with stone having a coefficient of wear as low as 7, a toughness as low as 7, and a hardness as low as 14. The variability of our rocks early directed our attention to the matter of rock selection, and from what I have seen of the service rendered by rocks of various character, I believe that these values are too low for the wearing or top stone.

In all our construction we aim to use a rock having a coefficient of wear

of not less than 10 in the surface or top course. Careful canvass of the supply field will usually make it possible to better the state specification low limit of quality at least, and in our vicinity it usually adds little to the cost to get our desired minimum of quality in the stone.

Design of Sub-grade.—Proper design of the sub-grade and sufficient body or mass in the lower course are essential for the securing of a serviceable highway with either macadam type. This, of course, leads to the question of drainage. As on every other road type, drainage is essential. Surface water must be taken care of, and so far as possible, the source of capillary water controlled. After this is done, you have obtained a certain bearing power in the sub-grade. Your bottom course must then be so designed as to thickness that this sub-grade will not be overloaded and deformed by the strains from traffic.

It is my opinion that rocks meeting the requirements in the specifications of the state highway department, above mentioned, are sufficient in quality for use in the lower course, and I believe that economy may be secured in many instances by using a poorer rock in the lower course, though possibly of larger sizes than now specified, and good rock in the wearing course. The thickness of the lower course made of the cheaper rock can then be varied where necessary to accord with the supporting power of the earth sub-grade.

In this matter of determining pavement thickness, impact must not be forgotten. We learned in physics in my school days that the inertia of sufficient mass would overcome and prevent the transmission of an impulse, and I distinctly remember a stunt that was used in the theatres in those days wherein the principle was given a practical application. In this stunt a man supported himself between two chairs, his head upon one and his feet upon another. A heavy stone was placed upon his chest and the stone was then broken with a full swing of a heavy sledge hammer. It is very apparent what would happen if the heavy stone was not over the man's chest.

I have stated this matter bluntly and in unscientific language purposely. It is not meant to belittle recent scientific research tending to economy in materials, but with the present demand upon road money and the disposition to spread it out, care should be taken in making any road design thinner until it is proved that theory and good practice are in accord. Particularly in these cheaper types of roads, if we should err it should be on the side of excess mass.

Causes of Failure.—Nearly all of the failures I have seen in either penetration roads or surface treated water macadam were apparently from one of two primary causes, or at least these causes contributed to the failure, and these are the design of the lower course with regard to thickness and the bearing power of the grade and the quality of the stone.

In general these types of road are applicable under medium to heavy traffic when proper supporting strength for the traffic load is possible of accomplishment. They will be found, if properly built, pleasing to the traveling public and fairly easy to maintain.

Sand-Clay, Top Soil and Sand-Gravel Roads

The committee on Structural Design of Highways, of which A. T. Goldbeck of the U. S. Bureau of Public Roads is chairman, in its report Nov. 8 at the 3rd annual meeting of the Advisory Board of Highway Research, gives the following suggestions for the construction of roads of the above mentioned type:

For successful roads, there is required—

(a) Graded mixtures capable of making a dense mass on consolidation. The best mixes run as low as 20 per cent porosity.

(b) Uniformity of composition secured by thorough mixing.

(c) Heavy compacting from the bottom upward. This is usually done by traffic. There is need for a type of multiple rim roller to hasten and unify the degree of compactness imparted to these roads during construction.

(d) The mixtures must have a liberal amount of coarse material above No. 60 sieve.

(e) Depth of compacted surface should be 10-12 in. Crown of ¼ in. per foot is sufficient.

Highway Engineering and Highway Transport Education

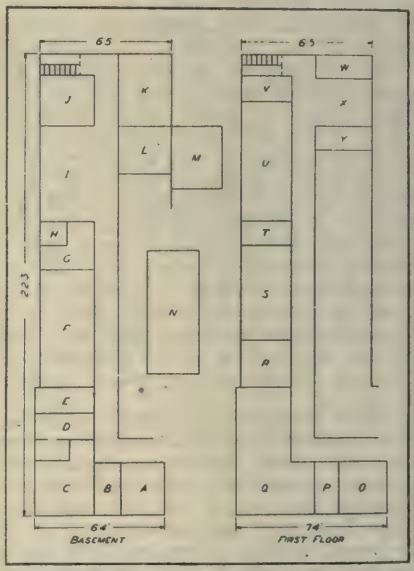
University of Michigan Now Offers 25 Courses and Has Provided 20,000 Sq. Ft. of Space for Department

The University of Michigan, in 1919-1920, offered the first course in highway transport to be given in an American educational institution. The number of courses in highway transport now numbers eleven. The rapid development in educational work in highway engineering and highway transport is indicated by six courses in highway engineering being offered in 1918-1919 and 25 courses in highway engineering and highway transport being given in 1923-1924.

The Board of regents has made provision for the personnel of the new division by establishing a chair of highway engineering and highway transport and the appointment of an associate professor, an assistant professor, a librarian of the Davis Library of Highway Engineering and Highway Transport, an instructor and three assistants in highway engineering.

Co-operative Relationship With State Highway Department.—At the time of the organization of the division, an ideal arrangement was made with the Michigan state highway department under which all the testing of highway materials for the department would be made in the university laboratory. This co-operative relationship has been efficiently developed in the interests of both the state and the university. The activities of the laboratory embrace undergraduate and graduate courses in highway materials, research work by members of the staff, fellows in highway engineering and candidates for the master's degree, routine examination of materials, and the collection of data relative to highway materials, especially deposits of sand, gravel, and rock. During the year ending June 30, 1920, the routine work included the testing of 3,641 specimens, while in the year ending June 30, 1923, the number of specimens tested increased to 6,831. The materials tested included portland cement, sand, gravel and stone aggregates, concrete, ledge rock, paving brick, corrugated metal pipe, clay tile and pipe, reinforcing steel, calcium chloride, tar, asphalt, oils, emulsions, bituminous mixtures, and paint.

Fellowships in Highway Engineering and Transport.—Through the generosity of Mr. Roy D. Chapin and the Detroit Edison Co., one fellowship in highway transport and three fellowships in highway engineering have been available each year since 1919-1920. Each fellowship pays the sum of $250 with an allowance of $50 for



Plans of the Basement and First Floor of the East Engineering Building Assigned to the Division of Highway Engineering and Highway Transport.

Key to Basement Floor Rooms

HIGHWAY LABORATORIES: A. Sample Storage Room. B. Damp Room for Cement and Concrete Specimens. C. Equipment Room. D. Locker, Wash and Shower Room. E. Balance Room. F. Laboratory for Testing Asphalt Cements, Tars, Oils and Bituminous Mixtures. G. Laboratory for Testing Paints and Metals. H. Computing Room. I. Laboratory for Testing Sand, Gravel and Stone Aggregates. J. Cement Testing Laboratory. K. Rock and Brick Testing Laboratory. L. Receiving Room. M. Highway Material Bins, Elevator and Delivery Chute. N. Concrete Testing Laboratory (located under main entrance lobby).

Key to First Floor Rooms

O. Office of Professor of Highway Engineering and Highway Transport and Seminar Room. P. Stenographer's Office. Q. Davis Library of Highway Engineering and Highway Transport. R and S. Lecture Rooms for Graduate Courses. T. Office of Assistant Professor of Highway Engineering and Highway Transport. U. Highway Engineering Drafting Room. V to Y, inclusive. Offices of Associate Professor of Highway Engineering and Staff of Michigan State Highway Laboratory.

expenses. Many high grade reports covering important research problems have been prepared by the fellows. The annual competition for these fellowships has been keen, there being 63 contestants in 1922-1923. Graduates of high standing of many institutions have been attracted by these fellowships, the fellows appointed having been graduates of Carnegie Institute of Technology, Colorado State Agricultural College, Cornell University, Dartmouth College, Iowa State College, Kansas State College, McGill University, Michigan Agricultural College, University of Colorado, University of Maine, University of Michigan, University of Missouri, University of West Virginia, and West Point. A wide range of professional activities is represented by the men appointed. The 1922-1923 fellows occupy the following positions: Major, Quartermaster Corps, U. S. Army; Resident Engineer, U. S. Bureau of Public Roads; Assistant County Engineer, Texas; Instructor in Highway Engineering, University of West Virginia.

Graduate Short Period Courses.—It has been found that graduate semester courses only meet the needs of a small percentage of practicing highway engineers and men engaged in highway transport who desire to obtain advanced instruction as such courses are not given during periods when it is practicable to secure a leave of absence. Recognizing this condition, the University, in 1919-1920, offered graduate short period courses in highway engineering and highway transport, leading to the degree of master of science or master of science in engineering, arranged especially for men engaged in the practice of highway engineering and highway transport. These courses are given in periods of two weeks each during the months from December to March, inclusive. Each course consists of 30 lectures, or the equivalent thereof, and counts as two hours credit towards the total of 24 hours required for the master's degree. Persons of mature age, who do not hold collegiate or technical degrees, but who give evidence of fulfilling the prerequisites of a given course may register as special students, not candidates for a degree. In the first year, 1919-1920, when such courses were offered at the University of Michigan, the attendance was 29; while in 1922-1923, 110 attended these courses, the average age of the men being 27 years, ranging from 23 to 56 years. These men came from the U. S. Bureau of Public Roads, state, county and municipal highway departments, contractors' organizations, companies manufacturing motor trucks, highway machinery and materials, universities, and from the field of highway transport. During 1923-1924, 18 graduate short period courses will be offered, ten in the field of highway engineering and eight in highway transport. These courses will be given by a staff of eight professors and ten non-resident lecturers.

Library Facilities.—Efficient graduate instruction requires exceptional library facilities for research work and collateral reading. The university is fortunate in being the present custodian of the Davis Library of Highway Engineering and Highway Transport, which is the most complete collection of literature on these subjects in existence. In addition to books, reports, specifications, monigraphs, and files of trade publications, all technical periodicals which contain articles relative to highway engineering and highway transport are on file, hence the latest literature on the science and art of these subjects is available. The library is equipped with eleven comprehensive indexes covering its books, reports, specifications, pamphlets, catalogs of materials and machinery, and literature on highway engineering and highway transport.

The development of the activities of the Division, the rapid increase in the enrollment of graduate and special mature students, and the expansion of the work of the highway laboratory, influence the board of regents to allot 20,000 sq. ft. of working space for the offices, library, drafting room, graduate lecture rooms, and laboratories of the Division of Highway Engineering and Highway Transport in the new East Engineering Building, which was opened for use at the beginning of the present collegiate year. The following keys to the plan describe the uses to which the 25 rooms in the basement and on the first floor of the north wing have been assigned.

Pavement Foundations

Relation of Depth to Strength Discussed in Paper Presented Nov. 15 at 29th Annual Convention of American Society for Municipal Improvement

By CLARENCE D. POLLOCK,
Consulting Engineer, New York City

The foundation is a very important part of a pavement and is a considerable item in both the first cost and in the maintenance of the pavement and should therefore receive the careful consideration which it deserves. The foundation should be sufficient to transmit the load on the pavement surface to the sub-grade without material deformation and spread the load over a sufficient area of the soil so that its intensity does not exceed the safe bearing power of that soil. Too little attention has been paid to this portion of the pavement in the past, but with the much heavier loads of modern traffic more consideration is being given this matter. The Bureau of Public Roads has made and is now making tests to obtain more data in regard to the behavior of slabs under varying conditions of loading and impact and different conditions of subsoil, and others have been working along similar lines, but there remains a great deal to be learned concerning this subject.

Foundation on Good Sub-Soil.—An old macadam pavement has proven a good foundation in many cases when it was not necessary to make openings in it for sub-surface structures, but usually in city streets the most satisfactory foundation is one of portland cement concrete, commonly mixed in the proportion by volume of 1 part cement to 3 parts sand and 6 parts of broken stone or clean washed gravel. This foundation is generally laid either 5 or 6 inches in depth upon a well compacted sub-grade. Where the sub-soil is sand or sufficiently porous material to provide good drainage, these depths have proven sufficient even for present day traffic. For instance, in the Borough of Manhattan, New York City, with 6 inch depth of concrete foundations the chief engineer of highways stated at the Paving Conference in Philadelphia in October, 1921, that for a considerable period the cost of repairs due to foundation failures had been kept separately and at that time it amounted to less than one-tenth of 1 per cent of the total cost of repairs per year. Any increase in depth of foundation here would surely be unnecessary and a waste of money. Some cities have had a tendency to lay heavier foundations, but with good sub-grade material it would seem to be expensive insurance. It is true that New York has generally good subsoil conditions, but it is an ever changing city and probably has more construction openings made in its pavements per mile per year than any other city. There is frequent settlement of the sub-soil in these cities, but the concrete usually bridges over the moderate sized ones and carries the traffic. On Fifth avenue it was found that 6 in. of concrete foundation had bridged over a span of 6 ft. and had carried the traffic of that heavily travelled thoroughfare safely for years, although buses on that street when loaded weigh from eight to ten tons and carry from six to ten tons on the rear axle.

Improvement of Sub-Grade.—When the sub-soil is of clay or other material which cannot be readily drained, from the present progress of tests it would seem advisable to improve the sub-grade rather than to weight it with a heavier foundation. In considering the bearing power of soils, a dry clay is usually capable of sustaining a load of 5 tons per square foot, but when very wet the same clay may not sustain more than 1 ton per square foot. By excavating a few inches additional and replacing with sandy or gravelly material the load will be spread so that with this and the better drainage a much greater load may be supported.

The foundation cannot act as a beam until the sub-soil gives away sufficiently to allow it to act as such. The better the sub-soil the greater the load required to deform the foundation. The Washington tests show that with the sub-grade support the sustaining power of the concrete foundation varies more nearly as the square of the depth than directly as the depth.

Load Transmission by Sub-Grade.—Measurements show that the foundation in transmitting the load to the sub-grade does not transmit it so that the pressure intensity is uniform. The pressure intensity is highest directly

under the load, and spreads out over a considerable area, diminishing to nothing at some distance from the load. The intensity of pressure under the load must exceed the bearing value of the soil underneath before the foundation can act as a beam. Even a macadam, bituminous macadam or bituminous concrete foundation will not be deformed until the intensity of pressure directly under the load exceeds the bearing value of the sub-soil. If the load is stationary or if the surface of the pavement is very smooth there will be simply the static pressure, but if the surface of the pavement is a little rough there will be impact and if the surface is quite rough this impact may amount to four or five times the static pressure. This is greatest when the tires are badly worn; with good, well-cushioned tires the impact apparently approaches more nearly the static load, and hence the advisability of securing as uniformly smooth a surface to the pavement as possible in order that the impact of moving loads may be eliminated as completely as can be done.

Tests by U. S. Bureau of Public Roads.—In the Bureau of Public Roads tests with slabs on wet and dry soils, the impact tests punched through the 4 in. slabs, but those of 6 in. in depth and greater were simply cracked on up to those 10 in. thick which could not be broken by their apparatus even on the wet sub-grades. According to this a thickness of 10 in. should be sufficiently great to carry any load that might come upon the pavement even with a wet sub-grade which may be more or less plastic. However, we are not so likely to have wet sub-grades in city streets subject to heavy truck traffic as the pavement is usually impervious to water and likewise the sidewalks are generally paved so that there is much less likelihood of sub-soil troubles here than with suburban roads. But should there be bad sub-soil conditions, in general it will be found much less expensive to improve the sub-grade than to pay for four extra inches of concrete in addition to the extra grade removal which alone would in most cases be sufficient when replaced by a more porous coarse-grained material which is not affected materially by water as are the very plastic soils such as many clays. With proper support from the sub-soil and a reasonably smooth surface to the pavement, a thickness of 6 in. for the concrete foundation seems adequate, especially as most heavy loads are now hauled on auto-trucks having rubber tires. The trucking interests have found that it is not economical to carry loads in excess of about 750 lbs. per inch width of tires. This insures wide double and triangle solid rubber tires on each rear wheel and a good distribution of the load over the pavement so that by the time it is spread through the thickness of the pavement and the concrete foundation the pressure intensity is usually well within the supporting value of the soil. Some states have limited the loads permitted on their highways, but here we have a limit placed by the effect on the truck owners' pocketbook, which is more easily enforced than the other.

Supporting Power of Concrete Foundation.—When in exceptional cases it may be necessary to use a greater depth of concrete than 6 in., it should be remembered that the supporting power of the concrete foundation varies about as the squares of the depths, as for example: 7 in. depth concrete would have about one and one-third the supporting power of 6 in. concrete; 8 in. concrete one and three-quarters; 9 in. concrete two and one-quarter, and 10 in. concrete three times nearly the supporting power of 6 in. concrete. By keeping this in mind it should prevent wasting money in using too great an increase in depth in special cases.

Another matter that the tests have brought out is the fact that while the compressive strength of 1:3:6 was 50 per cent of that of the 1:1½:3 concrete, the difference between the beam and slab strength of these two mixtures did not exceed 20 per cent.

Damage from Water Entering Sub-Grade Material.—In addition to damage from heavy loads the pavement, including its foundation, may be injured by water entering a clayey or other plastic sub-grade material from terraces or sidewalks and lifting and cracking the foundation and pavement by the swelling of the sub-soil. Sometimes this may be caused by frost heaving the foundation when there is a large amount of water in the plastic soil under the foundation. During the past season the writer was engaged upon an examination of some breaks in foundation and pavement where a

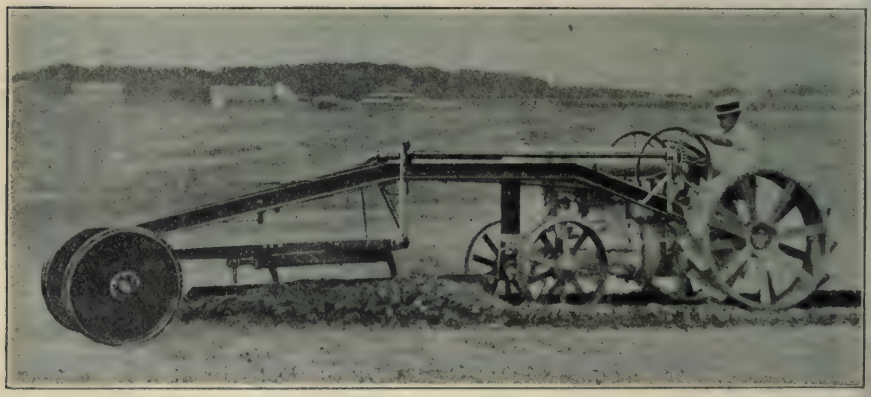
study of the conditions shown by openings and the history of the breaks as to when they were noticed after the completion of the pavements and before freezing weather and the soil condition in the terraces on the uphill side and the clay of the sub-soil showed conclusively that the breaks were due to the soil conditions and not to any loads to which the pavement had been subjected. These are further reasons for improving the sub-soil rather than increasing the depth of the foundation, as a considerably heavier foundation would have probably been broken by the heaving of the clay when it became wet, and if not by this, then later by the action of the water in the sub-soil freezing, and lifting the pavement.

About 20 years ago the author had several streets paved with asphalt on concrete foundation in a suburban development, where there was a layer of clay directly under the foundation and back of the curbs there were wide grass plots. A severe winter followed a wet fall and caused this pavement to be lifted as much as two inches in places as evidenced around sewer manhole heads. After the frost went out of the wet clay the pavement settled back, but unevenly, and cracked badly in so doing. Since that experience he has been very chary about placing the foundation directly on clay or other plastic material if there was any chance that water might penetrate it. Whether in a cold or in a warm climate as water alone will cause it to swell and lift the foundation and frost will increase its volume still more.

From our present knowledge we believe that a 6 in. depth of foundation is sufficient to carry modern traffic, provided the sub-soil is good, and if it is poor that it is better to improve the sub-soil rather than to use additional concrete in such cases.

1-Man Road Grader and Maintainer

A new 1-man road grader and maintainer, perfected this season by the Gilbert Manufacturing Co., Aberdeen, S. D., is illustrated. The machine has a wheelbase of 16 ft. and weighs 4,200 lb.; with wheels weighted for road building the weight is 8,000 lb. It is stated that the tractor can be taken out or connected up in less than 5 minutes by the operator, and as no mechanism is added to or taken from the tractor, it can be used for other purposes than power for the maintainer. It is stated also that on account of the power being at the rear the machine makes a very successful snow plow. The position of the blade ahead of the power likewise, it is claimed, makes it a good bull dozer or hole filler, as it can be run forward or backward readily. The machine can be furnished with a 6 ft. or 8 ft. mouldboard.



Gilbert Road Grader and Maintainer.

Taxable Valuation Per Mile of Highway.—Rhode Island has a taxable valuation of $5,956,295 per mile of primary highway, ranking first in the United States.

Modern Construction of Brick Pavements

Paper Presented Nov. 15 at Annual Convention of American Society for Municipal Improvement

By WILL P. BLAIR,

Vice President, National Paving Brick Manufacturers' Association, Cleveland, O.

At the meeting of this society at New Orleans, La., in 1919, we stressed the lack of information as to the conditions upon which we place the wearing surfaces of our streets and roads. We little realized then that our suggestions would be taken as seriously as they subsequently were. Results did follow by the appointment of a committee by the Federal Highway Council, for research of natural influences involved in the subgrade and its relation to road surfacing and traffic.

Influence of Water on Subgrades.—One of the principal discoveries influenced by the activities of this committee disclosed the fact that subgrades of most soils throughout the country were subject to contraction and expansion, due to the influence of water. That the forces of expansion in the case of a saturated subgrade was one of extraordinary power, often resulting from its expanding power, in the destruction of rigid surfaces, such as cement filled brick roads, which hitherto had met with the approval of the industry.

As soon as this fact was established, together with information ascertained as to other agencies of destruction, it became perfectly apparent that the construction of brick wearing surfaces would have to be changed in order to meet with less effect, the destructive agencies discovered.

Refined Asphalt Filler for Brick Pavements.—In the meantime, the manufacturers of vitrified brick, through their local organization known as the Western Paving Brick Manufacturers' Association, had discovered and utilized a certain refined asphalt, which had the quality of maintaining its place in the brick joints, under extreme high temperature and did not become rigid and fragile under the influences of low temperature. Experience with this filler, covering a period of about eight years, demonstrated its extraordinary merit.

It was at once recognized, in view of the newly discovered agencies of destruction of rigid pavements, that this method of construction, using this character of asphalt as a filler, afforded sufficient flexibility, so that these forces operating with an upward thrust against the brick surface, had little injurious effect. It was proved by experience that this filler practically protected the edges of the brick equally as well as the cement filler. In the light of this knowledge, there was but one thing to do and that was to strongly recommend to the engineers and the public the use of this particular refined asphalt as a filler for brick pavements, as affording a quality subject to the least possible injury from either traffic or these natural agencies of destruction, and this in brief is the reason for the National Paving Brick Manufacturers' Association strongly recommending this method of construction.

Important Details of Construction.—It must be understood that the use of asphalt filler in no way obviates or lessens the necessity of carefully complying with the details of construction, which are so well understood to contribute to the worth and durability of a brick pavement. Nor is the mere use of this filler sufficient to realize the ideal pavement possible, unless the exact and proper refinement of the asphalt is used and it is properly and skillfully applied. Its use must also be accompanied by the skillful installation of other requisites of the improvement as a whole, which constitute and are necessary for the ideal finished pavement.

These requisites are unfortunately often either carelessly dealt with, or ignored altogether, and are bound to result in unsatisfactory pavements. It is essential, of course, that the filler be applied so that the joints shall be completely filled.

Other important details subject to neglect and oversight are:

First: The stabilization of the subgrade by reducing to a minimum the possible moisture content.

Second: The smoothness of the artificial base.

Third: The uniform compression of

the sand bed upon which the brick are placed. Unless compressed, the brick wearing surface will ultimately conform to any unevenness of the base surface. This requirement can only be accomplished by using a hand roller and filling the depressions noticed after each rolling. Three to four repetitions are necessary to accomplish the desired result. Compliance with these details will secure an ideal pavement, and avoids the impairment of the pavement of all possible destruction from contraction and expansion forces.

What Contractors Are Doing in Highway Research

Report of Highway Division of Associated General Contractors of America

In undertaking the investigation of certain subjects concerned with highway developments, The Associated General Contractors have proceeded on the following assumption.

1. That problems of design and engineering will be successfully solved by the country's technical and professional minds.

2. That the development of local and state highway systems to meet the needs of agriculture, industry and pleasure will be developed by highway engineers in co-operation with representatives of these various interests and in spite of adverse political influence, and

3. That it is the duty of construction companies to study the means of building these systems properly and economically.

With this in mind, therefore, the association has concentrated its investigations upon those things that effect the cost of construction. These subjects are in the last analysis the controlling factor in determining whether the engineer shall be able to execute his conceptions and render his utmost service, and whether the public, which he is attempting to serve, will appreciate his efforts and receive a satisfactory mileage for its appropriation.

The field of research and investigation that may properly be assigned to construction companies is practically virgin insofar as recorded data and authentic information is concerned. Text books and treatises have been written in great numbers, but they deal primarily with those factors that are more or less definite in character, and fail to touch the less tangible problems involved in the inexact science of construction economics. It is to problems of this nature, concerned more directly with the business end of construction, but also to a great extent with the business of the designer, that the Associated General Contractors are devoting their efforts.

The principal subjects under investigation may be outlined as follows:

1. Material Supplies.
2. The Field Working Force.
3. Construction Methods.
4. Equipment Development.
5. Seasonal Suspension of Work.
6. Preventable Hazards in the Industry.
7. Comparative statistical tabulations.

The following is an outline of the work which the Associated General Contractors are carrying on in the individual field:

Material Supplies.—Data are being compiled from Government and industrial sources to show the quantities of the principal construction materials necessary to serve the industry, so that engineers and construction companies in laying their programs may have information on production that will assist them in fitting their demand to the production capacity.

Field Working Force.—Efforts are being made to induce young men to join the ranks of construction labor and to train them in the use of specialized machines that are rapidly increasing in highway construction. Incident to this work is the tabulation of estimated shortages in the study of wages and cost of living.

Methods.—A study of methods is being carried on by individual companies, as the Associated General Contractors as an organization have not yet obtained the funds sufficient to carry on this work. Reports of progress and new methods are furnished however, by individual companies to the association and to the trade magazine..

Equipment Development.—In co-operation with manufacturers of con-

struction equipment, the improvement and development of machines is being handled through the Joint Committee on Construction Equipment, which has to date practically completed work in two lines, namely, wheelbarrows and concrete mixers. These items of plant have been standardized within the past year and a time limit of January 1, 1925, has been set for the elimination of non-standard types. The wheelbarrow standards have already been put into effect.

Seasonal Suspension of Work.—The saving of construction costs that may be produced by continuous operation in the construction industry has never been estimated but the tendency of this continuity is well known. The Associated General Contractors for the past two years has devoted considerable effort and money in seeking to interest other elements of the industry in this question. Its policy has been that, rather than wait for quantitative estimates and exact data, it could more profitably urge adoption of the policy knowing that the energy extended would result in great economy. With this question is closely linked the problem of winter construction methods in which the co-operation of the engineering profession in experimental work is urgently needed. How far the seasonal depression can be eliminated in the highway field is uncertain, but the consensus of opinion is that where it can be brought about, the efforts will effect a significant saving.

Removable Hazards of the Industry.—As one of the important elements of cost in a construction project, is the assumption of certain hazards incident to the business world or resulting from natural causes. An effort is being made to induce the owners of public construction who assume those hazards which such owners can most economically assume, rather than incorporate them into the cost of construction. Many of these hazards occurring but once in the life time of a construction company are sufficient to throw it into bankruptcy and it must obviously protect itself by insurance or contingency charges. The infrequency of such event makes it considerably more economical for the owner to accept such hazards. Work on this subject is being continued in co-operation with the American Association of State Highway Officials and various architectural and engineering organizations. A report upon the subject was issued last December by the joint committee of the first named organization and the Associated General Contractors.

Comparative Statistical Relations.—In order that construction companies and others interested may keep track of the trend of various factors influencing the industry, graphical analysis comparing these factors are being carried in the magazine of the Associated General Contractors. Among the statistical compilations carried from month to month are a construction cost index; a construction volume index, based on the quantity of material shipped; index numbers of wages, cost of living and material prices; contracts awarded; volume of transportation and other data of a similar nature.

Statistics pertaining to the construction industry have been meager in past years, but now tabulations are being started and within the course of a few years sufficient data will be available to intelligently interpret the trend of economic forces within the industry.

The Associated General Contractors, in common with other national organizations, are restricted in their research work by lack of personnel, but it is anticipated that work of this nature will be expanded materially within the next two or three years.

One of the most important subjects upon which the construction companies of the country would like to see a definite determination made by the engineering profession, is the question of hardness of aggregate and their suitability as road materials. At present aggregates of different French coefficient are specified in particular states, apparently for highways of the same general type. Conclusive information upon this subject will doubtless make possible the utilization of many local sources of materials, and result in a decrease of unit costs.

Population Per Mile of Highway.—Rhode Island has an average population of 3,640 per mile of primary highway. Massachusetts comes next with 2,680, and New Jersey is third with 2,358.

When Should Motor Trucks Be Retired

Method of Determining Proper Point at Which to Replace Vehicle Described in Motor Transport

By F. J. SCARR

It is impossible to predict here what will be the proper length of a truck's life. This depends on too many conditions that vary with each installation, but the writer believes that the period of greatest economy will prove to be much shorter than is now usually adopted as correct.

The length of this period is different, not only for each type of vehicle as to manufacture and size, but for each vehicle, even of the same make and capacity, and even for those employed in the same class of service. Therefore, to determine the proper time to retire any unit of a fleet, requires that each be considered as a separate problem, just prior to a periodical overhaul or major repair.

Accurate Costs Essential.—To consider each installation as a separate problem requires that accurate individual costs be kept. Each vehicle must be looked upon as a separate investment and be treated as such. As long as it is capable of producing proper dividends, which represent the difference between the total cost and the revenue, it is profitable to continue in service. When this margin diminishes to a point where the investment is a poor one or is sustaining a loss, the time has arrived for reinvestment. This total cost can be computed only from accurate and complete records. These records must be complete so that the total cost will represent what it actually stands for, rather than the partial costs which many operators consider the total.

The basis of any method of detailed and thorough analysis of economical operation is accurate costs. Costs, to be accurate, must include every item of expense involved. Accurate costs insure that the sub-division of the total can be determined for the purpose of comparison and study. This comparison enables the fleet operator to know how his costs fluctuate, how efficiently his various departments are operating, how his trucks perform under different systems of management, under different operating conditions and according to the age of the vehicle considered. Costs, to be applied against separate units in a fleet, in order to consider the retirement of each vehicle as a separate problem, require that individual records be kept.

Controlling Operating Factors.—Two main factors, which may be termed, in a general way, **supervision** and **maintenance**, determine the efficiency of a motor vehicle fleet. Each has a separate and distinct manner of influencing the output of the fleet, and of the individual vehicle. Each is equally important in the fleet's operation. A vehicle cannot haul tonnage or passengers at low cost without intelligent directions. Nor can it perform that work without proper maintenance.

The first of these elements, supervision, may be called external. The output performance of the fleet is as efficient as this factor is intelligent. This item is responsible for that large portion of costs known as **fixed costs.** Whether the large outlay of money in this portion of the operating expenses is a paying or losing investment, depends entirely upon good or poor external management. In a given fleet these costs are practically constant and become a large or small portion of the total cost per unit as the number of units handled becomes small or large, respectively. This calls for the greatest care and thought in the planning of work and the adoption and efficient use of modern equipment and methods.

Curves representing costs, submitted herewith will show that the expense controlled by this factor is practically constant from year to year, increasing to some extent in the cost per unit as a vehicle passes through the overhaul period. This increase in unit cost is due to the large number of days idle in the shop, with the consequent low figures in miles traveled and units delivered.

The second of these factors, maintenance, may be said to control the **variable costs** of truck operation,

namely, those charges incurred in keeping the vehicle rolling on the road delivering tons. The economy of this expenditure is as much dependent upon the quality of materials and workmanship entering into the manufacture of each vehicle as upon timely, correct and thoughtful maintenance. Few people realize the importance of this item in truck operation.

A Fixed Policy for Maintenance.—Few have given the matter sufficient consideration to know that maintenance is the one item of operation that must have applied to its solution a fixed policy that will remain fixed throughout the years.

Few have had the opportunity to observe the radical variation of the repair cost per mile or per period or its variation throughout a vehicle's life.

Few have stopped to consider that the repair cost is alone responsible for the fluctuation of costs from one period to another and that it is the sole cause of the gradual increase in cost "since installation" as the vehicle grows older.

It is this fluctuation in repair cost that eventually makes it more economical to renew the vehicle than to continue it in service until obsolescence forces its retirement. To observe the rise of this item from year to year requires that accurate and individual costs be kept.

Cost Variation.—The cost of operation of a motor vehicle, like any other machine, **increases as it grows older.** As parts wear, as members become fatigued from vibration or over-stressing, repairs become necessary. These repairs, as would be expected, become increasingly more frequent until the vehicle reaches such a state that a general overhaul or several major repairs are required. This results in a very long idle period and in high repair charges which make the cost per unit during that period extremely high. This is clearly pictured in Chart 1 by the broken line, which is a typical cost curve for an individual vehicle.

Since all parts are not replaced at an overhaul, thus resulting in a vehicle made up of old and new parts,

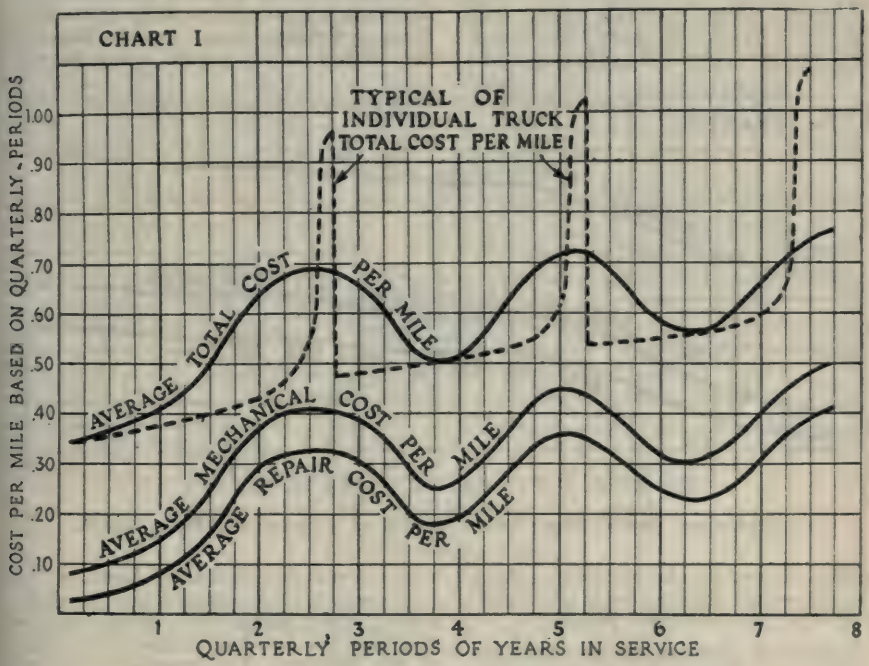


Chart I—Mechanical and Repair Costs and Typical Individual Truck Costs.

it is to be expected that it cannot operate as economically as a new vehicle and that it cannot be continued in service as long as a new one before the next general overhaul. This fact is borne out in the curves representing average conditions of a large uniform fleet—Chart I.

Not only does the period of operation become shorter and the cost of operation during each successive period mount higher; but the cost of each overhaul is greater.

Another item involving loss, and one which is seldom considered, is the time lost in the shop. During each successive period, the number of days idle increases during both the operation and the overhaul period.

The extent and manner of variation of the main factors in operation can best be presented to the reader by means of the following charts.

What the Charts Show.—The curves appearing in the charts are the result of an extended investigation of accurate operating costs over a considerable period and over a great many vehicles. These particular curves represent the costs of operation and performance of a large fleet of vehicles of the same make, model and capacity, operating under identical conditions as to maintenance methods and commodities hauled. While these curves represent a particular fleet, they are typical of a number of fleets investigated. The figures for any fleet will follow the same general lines but will vary as to distance of overhaul periods and degree of rise or fall of the curves. The examples presented will serve to illustrate the general points of this article. The capacity or make is not here disclosed since they are offered only to serve as an example of cost fluctuation.

Chart I.—Some of the early results of this investigation showed the radical variation of costs per mile or per period or per unit transferred during the various periods of a truck's life; and that as a truck grows older, the money expended to keep it on the road, delivering tons, mounts higher and higher. The curves are rounded into average conditions because a large number of vehicles was considered. This makes the curves more conservative and emphasizes the truth of the picture. The broken curve in Chart I shows the path of the cost of a typical vehicle from this fleet that conforms closely to the average conditions as to the location of the overhaul period.

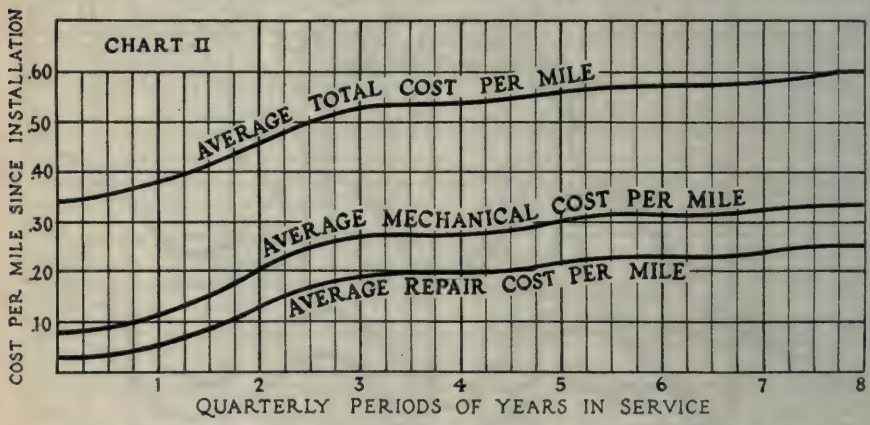


Chart II—Average Total of Repair Costs Computed on a "Since Installation Basis".

The sharp upward portions of this individual curve clearly mark the overhaul period wherein the number of days operated is much less and the cost of repairs is much higher. In this period over a month is spent in the shop, and the mileage and output are less than two-thirds the usual quarter, causing the greatly exaggerated costs for the period.

The usual cost per mile over the major part of each operating period, it will be noted, is not only gradually

increasing as it moves to the higher age, but each successive period continues to increase over the previous one, starting only slightly below the higher point in the last period between overhauls. Due to the fact that the curves of the individual vehicle are so abrupt and seemingly exaggerated, and since these will vary with each individual unit, the average curves alone will be considered for the purpose of arriving at the conclusions reached in this paper.

The curves in Chart I indicate the variation from one quarterly period to the next. These curves serve two purposes; first, to indicate the high points and the reasons for fluctuation over these periods; and second, to indicate the fact that marked variation occurs and that the general trend is gradually upward as the age advances. Under the maintenance system used in this fleet, the average overhaul periods occur at the following ages: 2¾ years, 5¼ years and 7½ years. Following the overhaul periods are operation periods of low costs, due to the improved mechanical condition of the vehicles. These periods of low cost, it will be noticed, never heach again the low levels of the first two years of operation.

Attention is again called to the fact that the repair cost is the chief cause of cost fluctuation. Experience and study of accurate cost figures prove that each overhaul is more costly than the previous one, and that the difference between the first and final years' expenditure is enormous. A certain fleet of large units whose cost figures have been available to the writer, cost for repairs per vehicle during the first year $300.00, and $2,200.00 during the fifth year.

Chart II.—The chief item of interest in cost fluctuations, to the operator who hauls for hire, is not so much the costs from period to period but the costs over a vehicle's life; particularly if he is in business with the intention of continuing for a number of years. Chart II is designed to show how costs act when averaged each period for the entire life up to that time. This curve being of this average nature is much flatter and shows much less fluctuation. It is from information such as represented in this chart that the economical life is to be determined. It is simply read as follows:

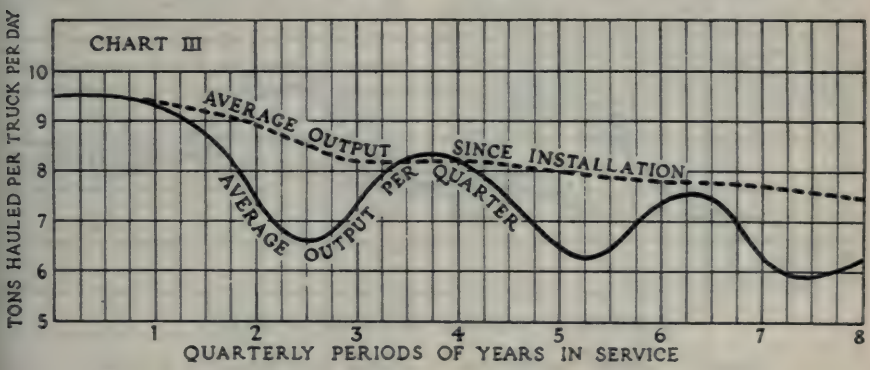


Chart III—Truck Output.

If a fleet is operated for one year it costs $.38 for each mile run. If that same fleet is operated for two years the per mile cost is $.46, and at the end of eight years it has mounted to an average of $.60 per mile for each mile run during that entire period. Therefore, revenue, that is dependent upon a certain margin over and above actual cost, should be computed on the final average cost basis, which in this case would be $.60. If the economical operation period proves to be less than eight years—say for example, two years, the fixed cost to be used in determining revenue would be $0.46.

Chart III.—The cost per mile or per day is of little value if its rates are based upon the unit hauled. In such cases the cost per unit is of prime importance. It is generally be-

lieved that the age of a vehicle has little effect on its output. This is as far from the truth as is the contention that obsolescence is the only factor in determining the proper age of vehicle retirement.

Chart III shows, in a general way, how the age of a fleet affects the output. It represents the output per available truck day. The action of the curves in this chart is directly opposed to that in Charts I and II. The output, computed on a quarterly cases (the solid line), can be seen to dip at the average overhaul period and rise during the periods of good mechanical condition. This action is due to the number of idle days during the overhaul quarters. This curve, like all others presented, is based on actual performance figures of a large, uniform fleet.

The "since installation" curve (the broken line), serves the same purpose as Chart II and is directly opposed to that picture. Attention is here called to the fact that this fleet, if operated only two years, would have averaged over nine tons per available truck day, while if operated for eight years it will average for the entire period only 7½ tons. Here again a warning is sounded to the large and small operator alike, who cares for economical delivery, that the longer the fleet is kept in operation (other things being equal), the lower becomes its average output. The man who hauls for hire must watch his step, particularly if he is starting out with new equipment, and is not familiar with the cost of operating old vehicles.

Chart IV.—It is unfortunate for the operator that the output and cost curves are opposed, as Charts II and III indicate. This has a terrifying effect upon the cost per unit hauled. The cost per unit hauled is computed by dividing the cost per period by the output for that same period. With the cost increasing as the output diminishes, the upward tilt of the cost per unit curve is doubly increased. Chart IV gives an approximate picture of the cost per ton of the fleet whose costs are presented in Charts I and II and whose average output appears in Chart III.

The curves in this final chart conform generally to the form of the cost curves. The movements are more exaggerated due to combining the costs and output. The solid line curve shows the fluctuation in the cost per ton computed on a quarterly period and is the result of combining Chart I with the solid line in Chart III. The radical fluctuation from quarter to quarter is, of course, very marked. The browen line curve is a combination of Chart II and the broken line curve in Chart III. The extreme increase in cost per unit indicated in this curve is of utmost importance to every operator.

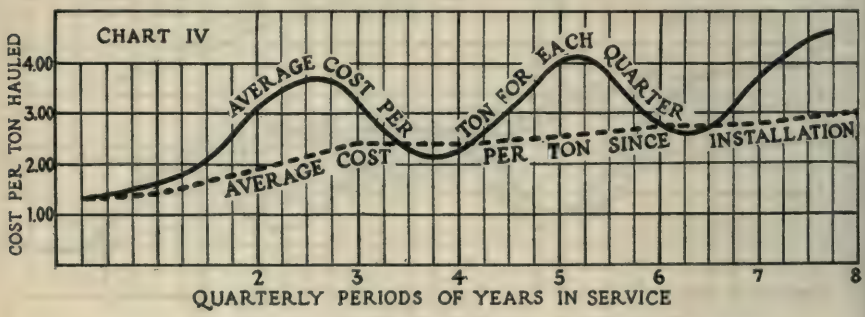


Chart IV—Average Cost Per Ton at Average Daily Mileage of 30 Miles.

While the average total cost since installation increases from the first quarter to the end of eight years of operation only 63 per cent, the cost per ton increases 227 per cent. Since, in the final analysis, it is the cost per unit hauled that interests the shipping public, Chart IV must indicate to everyone the positive need of determining the proper time to retire a vehicle, and to keep the fleet operating at the lowest possible cost.

As an example, a man having op-

erated a fleet of vehicles, whose performance may resemble the fleet whose costs and performance are used in this article, for a year, finds that his costs are $1.40 per ton. He signs a three-year contract for the same class of work at a rate of $2 per ton, a figure which he considers will net him a handsome profit of $.60 per ton, or 43 per cent of his costs. If he fulfills his contract, he will be hauling (as the broken line in Chart IV indicates) for $2 per ton what is actually costing him close to $2.40. In short, due to his ignorance of the trend of costs, he bids $.40 per ton, or 20 per cent lower than his actual costs, if he ceases to operate the the termination of his contract. However, if he continues to operate these vehicles throughout eight years, his bid would have been $1.00 per ton, or 33 per cent less than his actual costs.

Method of Finding Economic Point.—It is quite obvious that with the cost of operation gradually increasing as a fleet of vehicles grows older, and with the known fact that there is a limit to the amount (this limit may be set by competition or by the shipper himself) the shipper will pay for a certain class of service, the cost per unit approaches a point (far enough below the prevailing rate to insure a reasonable profit) which is the limit of a vehicle's economical service. It is a well known fact, too, as stated previously, that each vehicle, even of the same make, model, fleet and class of service, varies as to performance and cost. With these facts before us it is only necessary to set a method of arriving at the economical point of turning over a vehicle.

The Problem.—Since the period of greatest expenditure occurs at a general overhaul or time of a major repair, the period just prior to this occasion is chosen to decide whether it is more economical to overhaul the vehicle and continue it in service until the next overhaul period or to turn it in and install a new truck.

When a vehicle reaches the overhaul period the following plan should be followed: Estimate the cost per unit hauled for the period following, up to the time of the next overhaul, for both the old unit and the new. The formulæ submitted below are suggested for the solution of this problem.

Having computed the above two problems carefully, compare the results. If the result E is greater than L the indication points to the installation of a new unit. If the reverse is true, the unit should be overhauled and continued in service until a subsequent overhaul becomes necessary.

If the results are equal or very close, some further investigation is necessary before making the final decision.

A statement should be prepared showing the performance and cost of the old unit over its entire life up to date. This record should be carefully compared with the average figures for the fleet. (This fleet to include the vehicles of the same make, capacity and occupation.) If this comparison indicates that the truck in question has been giving exceptionally good and economical service, and the result of the first comparison is close, the vehicle should be continued in service. On the other hand, if the showing made is poor, the only course open is to turn it in for a new unit.

$$\frac{A + B + C}{D} = E =$$ cost per unit during period up to next overhaul if old equipment is continued.

$$\frac{F + G + H - I}{K} = L =$$ cost per unit during above period if new equipment is installed.

Old Equipment Factors for Period Up to Next Overhaul

A—Total cost of operation (less overhaul and repair) estimated.
B—Cost of overhaul (estimated from actual inspection).
C—Cost of repairs for above period estimated.
D—Output—days worked or units hauled (estimated from past).

New Equipment Factor for Above Period

F—Total cost of operation (less repairs).
G—Cost of repairs for period.
H—Book value of old equipment. (Present.)
I —Turn-in allowance of old unit (to include all credits).
K—Output days worked or units hauled (estimated).

Where special costs or considerations are involved, the above formulæ can be modified or augmented; but if worked properly and intelligently, can be used to solve this problem for any operator.

Depreciation.—It is desirable to have the depreciation period equal, as closely as possible, the economical life period. This can be accomplished only through experience. Each fleet of vehicles of the same make, capacity and occupation, will have its own period, depending upon its own experience. This is influenced by the operating conditions, which differ with nearly every installation. Under certain conditions, a truck will render economical service for a long period; while the same units, subjected to the rough treatment of road contracting or some similarly difficult work, will last but a short time.

The depreciation period can never be set to work equitably in the case of every vehicle involved. It can be set at the average life, however, and thus in th long run operate satisfactorily for the whole. The method of determining the economical point, outlined under **The Problem,** takes account of any amount undepreciated in the old unit being considered. Therefore, the failure of a truck to have a zero book value at the end of its economical life is not of utmost importance. Once having this system of retiring vehicles in operation, the depreciation period will be set from time to time at the average life of vehicles retired.

How to Determine Depreciation.—Each fleet may be classified under one or tow heads:

1. Those that are just starting to operate.

2. Those that have been operating for some time.

The former is easily settled. Such operators should secure the service of a competent engineer to investigate their problem and report as to the proper period to be used for each class of vehicle. Having started on an estimated depreciation period, this operator should keep accurate individual costs, and, applying the retirement plan suggested herein, determine for himself after a period of years, the correct average depreciation period.

Operators whose fleets have been in service for a period of years and who have accurate costs available, will by solving one of the above problems for a number of vehicles be able to determine the correct average period to apply to his books for each class of equipment. Operators who have no accurate costs available should start keeping them at once; and for the determination of the correct depreciation period to apply under the conditions which govern his operation, should follow the plan outlined for the operator just starting, as explained in the preceding paragraph.

This period of depreciation should not be confused with the economical life. These are two separate and distinct problems in spite of the fact that the former is dependent upon the latter for solution. Depreciation is simply a bookkeeping convenience and should approximate the economical life only for the purpose of applying costs to the periods in which they actually occur.

In conclusion, it is desired to emphasize the importance of keeping accurate records of the cost and performance of each individual vehicle. Each is an investment, apart by itself, and must be constantly scrutinized to insure proper returns.

Each must be retired when it becomes more economical to install a new unit. The "problem" must be computed in the case of each truck just prior to the overhaul period.

What the period of economical life is, cannot be determined in advance. One thing that this investigation points out very emphatically is that vehicles, operated under similar conditions of operation and maintenance as encountered by the fleet whose figures are herein represented, should, in general be retired at a much earlier date than is usually the case.

Indiana to Dedicate Large Highway Bridge.—The Indiana State Highway Commission on Dec. 12 will formally open the Hazleton bridge, one of the largest structures on a state road in the middle west. The bridge has 8 steel spans and 21 concrete spans of a total length of 2,002.5 ft. Four of these are 198 ft. each. The length of the south approach of 3,762 ft., and of the north 7,448 ft. The total cost was about $275,000.

Football Game Increases City Traffic by 150 Per Cent

All records for automobile traffic through Connecticut on a single day were broken Nov. 3 on the occasion of the West Point-Yale football game in New Haven. A census taken on that day by the Connecticut State Highway department, shows that a total of 32,923 passenger cars travelled in and out of New Haven during the 12-hour period from 8 a. m. to 8 p. m., which is far greater than at any previous major football contest in New Haven.

Comparison of the figures with compilations made during previous games there, as well as during normal periods, shows that this state drew sufficient automobiles on that day to provide for an average passage of 50 cars per minute at a given point.

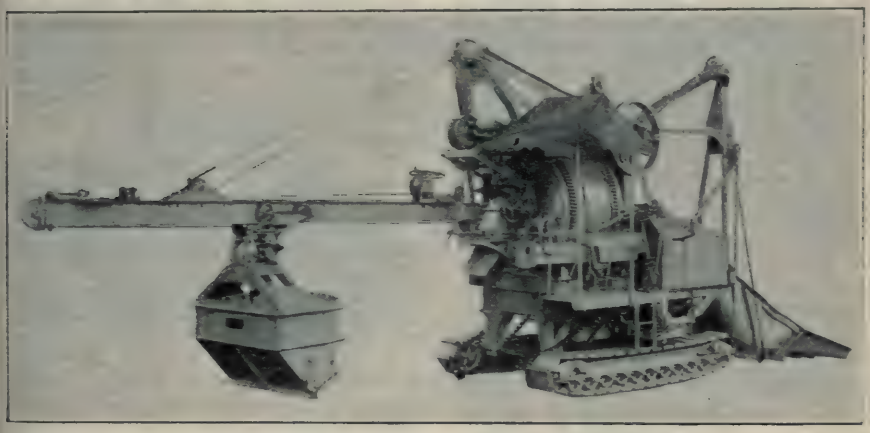
Stationed at seven points on the main arteries into New Haven employees of the highway department recorded every vehicle passing by from 8 a. m. to 8 p. m. The census showed that 17,189 cars entered the city and 15,734 came out. The figures for the Yale-Princeton game Nov. 12, 1921, gave 11,827 inbound cars and 12,195 outbound. Total traffic recorded of all makes of vehicles was 35,981 vehicles, compared with 26,016 in 1921 at the Princeton contest.

The total census includes trucks, motorcycles and teams. An interesting sidelight is the comparison of truck traffic with two years ago, which shows a remarkable increase from 1499 to 2397. Motorcycles numbered 238 compared with 215, and horse-drawn vehicles totaled 333, as against 280 in 1921.

An increase of approximately 40 per cent in the total traffic passing through the city over the 1921 day is shown by the census. The increase over the city's normal traffic, however, aggregates 150 per cent. The total traffic of all vehicles on a normal working day was shown to be 13,965 by a previous census taken at this time last year on a day when there was no football attraction.

Special Design of Koehring 21E Paver for City Work

For city paving work where a large capacity paver is desired, the Koehring Co., Milwaukee, Wis., has developed a special design of head frame on its 21E paver. The uprights supporting the sheaves through which the charging skip cables run are bolted and hinged in such a way that after the bolts are removed, the upper framework may be tipped back by the skip hoist clutch, thus reducing the height of the machine, and allowing it to pass beneath low telegraph wires and other obstructions.



Special Design Koehring 21E Paver for City Work

The minimum height from ground of the Koehring 21E paver with this special frame is 10 ft. 9¼ in. with truck wheels, 10 ft. 11¼ in. with half-length multiplane, and 11 ft. 2¼ in. with full-length multiplane.

This arrangement also permits the loading of machine on a flat car for shipment without any dismantling further than the boom and skip.

Pennsylvania to Have Stations for the Examination of Motor Vehicle Drivers

The Pennsylvania State Highway Department after Jan. 1 will establish in various sections of the state stations at which new applicants for licenses to operate motor vehicles may be examined. The act of 1923 provides that after Jan. 1 persons applying for drivers' licenses must be examined as to their fitness, their ability to operate a motor vehicle, and their knowledge of the laws of Pennsylvania and rules of the road. A number of stations will be established throughout the state—perhaps one in each county; and at stated times examinations of applicants will be held by members of the department's motor patrol. The examination will consist of an actual demonstration of the applicant's ability to handle a motor car and his knowledge of the mechanism of that car, coupled with an inquiry as to what he knows of the rules of the road and the state laws. Prospective drivers who make application for examination will be issued a learner's permit, good for 30 days, during which period he will be given his examination. If he passes this examination he will secure an operator's license. If he fails to pass he will be given another opportunity later on, and in the meantime his learner's permit will be continued. This, however, will not be good for any considerable length of time. Persons now holding a license to operate a machine will be entitled to a 1924 operator's license without an examination, but they must answer a series of 20 questions, calculated to show the department that they are capable and fit.

State Aid Highways in Connecticut.—With total requests from towns aggregating $2,227,000 for participation in the $1,000,000 fund made available by the last session of the general assembly for construction of state aid roads, the Connecticut state highway department has found it necessary to reduce allotments 50 per cent. Only 12 of the 169 towns in the state failed to seek a portion of the money. The towns are divided into two classes for participation in the state aid appropriation. Those with grand lists under 250,000 will have seven-eighths of the most of improving their state aid roads borne by the state. There are 34 in this group. The remaining towns, whose grand lists are valued in excess of $1,250,000, pay for one-quarter of the cost of the work, the state's share in this class being three-quarters. In every case, the complete cost of the work is paid by the state, and on completion of the work the highway department is reimbursed by the towns for their proportionate shares.

Transport Survey of Pennsylvania Highways

The Pennsylvania Highway Department on Nov. 8 started a transport survey that involves the operation of 78 truck weighing stations and over 300 recording stations, distributed over the state's primary and secondary highway systems. The survey will continue for an entire year, it is believed. The principal purposes of the survey are:

To furnish information regarding traffic density and weight necessary to a scientific road building and maintenance program in the state.

To furnish information regarding present traffic in order to be able to predict future traffic.

To determine daily and seasonal variation of traffic on primary and secondary roads.

To determine seasonal variations in type of traffic, commodities hauled, and length of haul.

To determine the amount and kind of freight transported over the highways.

To determine the extent to which this movement of freight is complete in itself, and to what extent it is a part of a through movement involving the use of other means of transportation for its completion.

To determine the extent to which the traffic over Pennsylvania highways is by vehicles licensed in the state, and the extent to which it is by vehicles licensed in other states.

To determine to what extent and for what distances various commodities are being hauled over the highways.

To gather information necessary to formulate a basis for scientific legislation on highway matters.

To determine the factors affecting the amount of traffic, both passenger and truck, on different highways in various parts of the state.

Rotary Snow Plow Attached to Fordson

The Dallmann-Fordson Snow Plow here illustrated, is designed to clear a single track instead of attempting to open a road to its full width. In operation the plow can be driven in high gear through the average fall of snow and will clean a path wide enough for one-way traffic. The return trip over the same route clears the snow from the opposite side of the road.

Power is first taken from the tractor through a specially designed Smith unit which, instead of terminating in a conventional pulley as in the ordinary Smith unit, transmits power through a pair of spiral bevel gears, a heavy steel propeller shaft, a heavy duty universal joint and forward drive gears.

The plow itself, with apron and snow propeller, rides on its own

Dallmann Rotary Plow Attached to Fordson.

wheels, which are of the pivoting caster type. Since the entire mechanism is free to rise and fall with the inequalities of the road, all strain on the tractor as well as on the driving mechanism is eliminated.

A special starting device, which enables the operator to spin the motor, assures an easy and quick start when the plow is in place.

The attachment of the plow is extremely simple. Brackets bolted on either side of the crankcase provide a pivoted anchorage. In attaching these brackets the studs and nuts connecting the two sections of the Fordson crankcase are utilized, and since no drilling or tapping is required, it can truthfully be said that the use of the plow in no way alters the tractor itself.

In operation the scooping action of the apron, combined with the forward motion of the tractor, piles the snow up in front of the propeller. The high speed at which the propeller works and the small quantity of snow handled by each blade at one time, provides a large margin of safety against clogging.

The advantages of the Dallmann Snow Plow are summarized by the manufacturers as follows: It is inexpensive. It can be operated over any type of road within reason, owing to its ability to accommodate itself to the irregularities of road surface. With the positive clutching and declutching action afforded by the Sunit unit power take-off, any tendency to stall in a heavy drift can be anticipated and prevented by "easing up" on the forward motion or by backing up, thus allowing the propeller to clear itself of the accumulated packed snow. It is compact and occupies little space when stored. It is substantially constructed and is suitable for use where a steady pace must be maintained over long stretches of road.

The plow is made by the Dallmann Machine & Mfg. Co., 923 Winnebago St., Milwaukee, Wis.

Paving Brick Shipments in October

That the paving season, because of a wet spring generally and a late start, is running later in the fall this year than is customary, is indicated by the continued heavy shipments of vitrified paving brick, as reported by the National Paving Brick Manufacturers Association. Shipments for the month of October were 34,287,000 as against 34,761,000 for September. Total number of brick manufactured was 34,317,000 for October and 34,457,000 for September. Stock on hand was reported at 76,613,000 for October as against 86,530,000 for September.

Ohio led all other states in the purchase of paving brick, buying 6,763,000 for city streets and 4,950,000 for country highways. Illinois, Minnesota and Pennsylvania followed closely in the order named.

Bond Issues for Highway Construction

Results on a census on bond issues contemplated and authorized for highway construction carried out by the Asphalt Association show that a total of $781,228,384 in bond issues, exclusive of federal aid, were reported under contemplation in the states, counties, townships and road districts of the country from Aug. 1, 1922, to Aug. 1, 1923, and that the sum of $617,029,537 was actually authorized to be expended. The amount reported as contemplated exceeded the $748,563,000 contemplated during the year previous by $32,675,384 and the sum authorized exceeded that of the year before by $75,304,757. The bond issues authorized from Aug. 1, 1921, to Aug. 1, 1922, amounted to $541,724,780.

Reports to the Asphalt Association show that the states, counties, townships and road districts of the various states had under consideration or contemplation, exclusive of federal aid, from Aug. 1, 1922, to Aug. 1, 1923, new bond issues for improved roads as follows:

Alabama	$ 350,000
Arkansas	3,380,000
California	12,750,000
Colorado	6,000,000
Connecticut	25,000
Delaware	1,100,000
Florida	10,355,000
Georgia	61,125,000
Illinois	52,325,000
Indiana	480,480
Iowa	51,114,000
Kansas	741,426
Kentucky	55,255,000
Louisiana	4,503,000
Maine	10,000,000
Maryland	340,000
Massachusetts	1,390,000
Michigan	14,178,350
Minnesota	54,294,000
Mississippi	2,045,000
Missouri	5,282,990
Nebraska	10,000
New Jersey	44,761,500
North Carolina	3,525,000
New York	3,082,400
Ohio	2,391,565
Oklahoma	17,825,000
Oregon	1,458,000
Pennsylvania	66,496,500
Rhode Island	500,000
South Carolina	7,733,000
Tennessee	78,807,500
Texas	72,703,000
Utah	130,000
Virginia	79,763,000
West Virginia	5,419,400
Wisconsin	1,174,000

Bond issues authorized during the year in the various states, exclusive of federal aid, were as follows:

Alabama	$ 6,605,000
Arizona	2,610,000
Arkansas	6,416,000
California	33,150,314
Colorado	15,000,000
Connecticut	125,000
Delaware	10,240,000
Florida	35,493,000
Georgia	1,005,000
Idaho	425,000
Illinois	123,638,000
Indiana	5,877,996
Iowa	17,435,000
Kansas	1,582,062
Kentucky	5,887,000
Louisiana	9,813,100
Maine	916,000
Maryland	4,658,000
Massachusetts	628,000
Michigan	9,564,250
Minnesota	19,311,679
Mississippi	5,325,000
Missouri	15,634,999
Nebraska	1,020,000
New Jersey	24,300,000
North Carolina	25,540,000
New York	5,990,000
Ohio	8,719,000
Oklahoma	4,915,000
Oregon	8,868,000
Pennsylvania	159,398,000
Rhode Island	805,000
South Carolina	5,611,000
Tennessee	984,000
Texas	18,406,500
Virginia	4,096,493
Washington	819,000
West Virginia	16,197,665
Wisconsin	7,464,000

State Highway Construction in Massachusetts in 1922

The total length of state highways in Massachusetts at the end of 1922 was 1,440 miles. During the year, the State Division of Highways completed on 35.70 miles of state highway, 7.05 miles of highways under the provisions of section 23 of chapter 81 of the General Laws, 90.79 miles of highways under the provisions of section 34 of chapter 90 of the General Laws, as amended, and 9.46 miles of highways under the provisions of special acts, making a total of 143 miles completed during the year.

Of the above roads completed this year, .87 of a mile was of water-bound macadam; 28.40 miles were of gravel; 6.71 miles were of bituminous concrete; 77.93 miles were of bituminous macadam; 2.28 miles were of water-bound macadam with an oil or tar surface applied; 15.46 miles were of reinforced concrete; 7.01 miles were of gravel with an oil surface applied, and 2.34 miles were earth roads, that is, surfaced with the best available material. During the year 1.67 miles of state highway were widened but not resurfaced, and 10.65 miles were resurfaced and widened. These figures are for complete work.

Widening Curves on Highways

Flexible Method Described in Paper Presented Nov. 15 at Annual Convention of American Society for Municipal Improvements

By G. A. CRAYTON

Highway curves, if sufficiently sharp, should be widened. However, there appears to be very little agreement in the practice of the several states in this country. The practice is shown graphically in Fig. 1. Observe that one state will widen a maximum of 8, and others no more than 3 ft. The greatest variation of opinion seems to be on curves of from 6 to 12 degrees of curvature. It is the purpose of this paper to develop a method of widening that will be sufficiently flexible to meet all reasonable conditions.

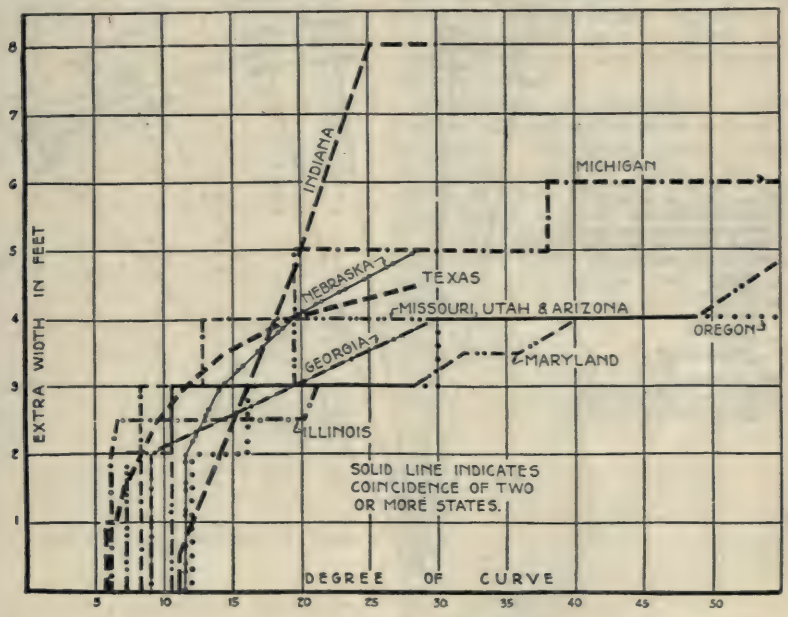


Fig. 1.

Reasons for Widening Curves.—There have been several reasons advanced for widening a curve. So far as the writer is aware, they are: to increase the "sight distance"; to promote a feeling of increased safety in the user; to allow for the almost universal tendency to "cut corners"; to provide for safety by placing additional widening on the outside of the curve; and to allow for the difference of track between front and rear wheels of a vehicle.

In a flat country free from obstructions such as buildings, forests, orchards, etc., widening will not improve the sight distance, and the small amount of additional width commonly used cannot compensate for such obstructions. In mountainous country on "supported" grades, curves are as a rule either in a draw or on a point. In the former case the sight distance is satisfactory without widening and in the latter the point itself constitutes the obstruction and a satisfactory sight distance at a reasonable cost cannot be obtained by this method. It is obviously better to "daylight" the curve on such a point as illustrated in Harger & Bonney's Handbook, third edition, page 34.

What the Accidents Reports Show.—Promotion of a feeling of safety in the mind of the user does not lend

itself to mathematical treatment, except perhaps in an empirical method of handling statistics. It is of interest in this connection to refer to a portion of the work of the Maryland Road Commission. From their very carefully reviewed accident reports, it appears that comparatively more accidents happen on tangents than on curves. Their report seems to show that on curves drivers use greater caution. A certain amount of fear, it would seem, is desirable. However, it is not good judgment to spend large additional sums in an endeavor to make our highways safe for inebriated or speed obsessed drivers. Certainly all the engineering talent with unlimited resources at its command could not make them safe against such drivers.

It is a great temptation to always take the inside of a curve, although half of the time we would thereby be traveling against traffic. But regardless of the additional width placed on the inside of pavement, we would still find many of the drivers on the wrong side of the road. The practice of marking a "deadline" to separate traffic lanes is recommended as less costly and more effective than widening for such a reason.

As the headlight of a motor vehicle throws but a comparatively narrow beam, it is possible when driving at night over an unfamiliar route to be unaware of a curve until well upon it. This has been taken as the reason for widening on the outside of a curve. There are some very apparent objections to this practice, such as causing of necessity an excessive sharpening at some point on the outer edge of the pavement, as well as the effective width being in ordinary cases too small to be of much service, etc. Labeling the curves with properly disposed signs is recommended as being cheaper as well giving more effective notice of curves than placing 2 or 3 ft. of extra width on the outside.

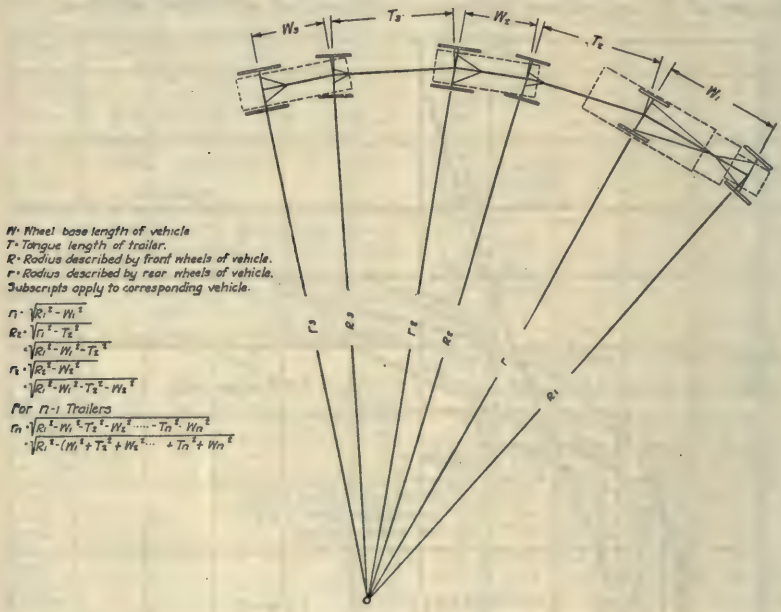


Fig. 2.

It is a well known fact that, when traversing a curve, the rear wheels of a vehicle will track inside of the leading wheels. Except in case of trailers built to track, each pair of wheels in a train will continue to track inside of those ahead of them. This, in the judgment of the writer, is the only logical reason for the practice of widening curves.

Determining Difference in Track of Trailers.—To develop a method for determining the necessary amount, it is first essential to determine the

kind, general dimensions and construction of the motor truck and its trailers. As a rule the longer trains will use "tracking" trailers. Our formula should, however, take account of the worst possible case, that of a motor truck of long wheelbase drawing a train of ordinary farm wagons. To make a few assumptions: (1) that there will be no side slip of the wheels; (2) that the path described by each pair of wheels is an arc of a

Radius of curve	Track differences					
	No trailer	One trailer	Two trailers	Three trailers	Four trailers	Five trailers
50	1.46	3 76	6 18	8 75	11 48	14 42
60	1 21	3 09	5 05	7 07	9 17	11.36
70	1 04	2 64	4 27	5 95	7 68	9 45
80	0 91	2.29	3.71	5 15	[illegible]	8 13
90	0.80	2 03	3 29	4 55	5 83	7 14
100	0 72	[illegible]	2 94	4 07	5 22	6 37
125	0 58	1 46	2 34	3 23	4 13	5 05
150	0.48	1.21	1 96	[illegible]	3 43	4.11
175	0 41	1 04	1 67	2 30	2 93	3 56
200	0 37	0 91	1 46	2 00	[illegible]	3.11
250	0 29	0 73	1 16	1 60	2 04	2 48
300	0 24	[illegible]	[illegible]	1.33	1 70	2 06
350	0 21	0 52	[illegible]	1 14	1 46	1 77
400	0.18	0 45	0 73	1 00	1 27	1 55
450	0.16	0 40	[illegible]	0 89	1.13	1.37
500	0.14	0.36	0 58	[illegible]	1 02	1 24
[illegible]	0 12	0 30	[illegible]	0 67	0 85	1 03
700	0 10	0 26	0.41	0.57	0.73	0 88
[illegible]	0 09	0 23	0 36	[illegible]	0 64	0 77
900	0.08	[illegible]	0.32	0.44	0 57	[illegible]
1000	0 07	0 18	[illegible]	[illegible]	0.51	[illegible]
1200	0 06	0 15	0 24	0 33	0.42	0 51
1400	0 05	0 13	0 21	0 29	[illegible]	0.44
1600	0 05	0 11	0 18	0 25	[illegible]	[illegible]
1800	0 04	0 10	0 16	0 22	0 28	0.34
2000	0 04	0.09	0.15	0 22	0 25	0.31
3000	0 02	[illegible]	0 10	0.13	0 17	0.21

Fig. 3. Table Showing Difference of Track in Feet.

circle, after equilibrium has been established; (3) that the center of the curve will be the common center of all paths; (4) that the front axle of each trailer is at right angles to its tongue; (5) that the rear axle is at right angles to its reach. While all of these are not strictly true, it is believed that the approximation is sufficiently accurate. The conditions as outlined will result in the formula as shown in Fig. 2.

To secure some specific figures, assume a truck with a wheelbase of 144 in., and from one to five trailers, each being an ordinary farm wagon having a wheelbase of 7 ft. and a tongue length of 13 ft. Working out values on this basis, values of difference of track are obtained as shown in Fig. 3.

At last year's convention of the American Society for Municipal Improvements, it was recommended by the sub-committee on sidewalks and street design that in general the width of roadway should be based upon a certain number of lanes of traffic and that a definite width should be allowed for each lane. We will apply this principle to the case in hand, and assume that track difference constitutes the reason for widening. Highways of sufficient importance to warrant widening should be designed for a minimum of two traffic lanes. Each of these lanes should have applied the track difference as its extra width or a two-lane road should be widened double the tracking difference.

Application of Method.—A better method of application is on a percentage basis. The usual over-all width of a vehicle is 5 ft. 6 in., which requires in usual practice a 9-ft. traffic lane; then if a given set of conditions of a curve and vehicles cause a track difference of 1 ft., the "effective" width of the vehicle and train together is 6 ft. 6 in., and the width

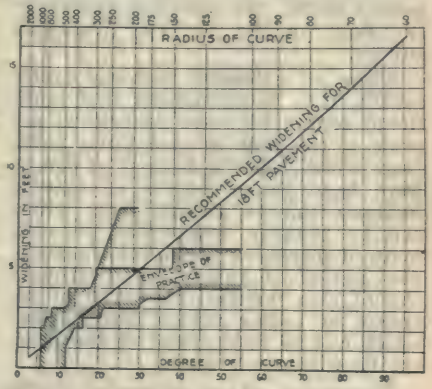


Fig. 4.

necessary for its traffic lane will be expressed by $\frac{9 \times 6.5}{5.5}$ in feet, or since two traffic lanes are under consideration, the total width of the curve would be $\frac{2 \times 9 \times 6.5}{5.5}$ or 21.27 ft., in which case the widening is 3.27 ft. This allows the same prooprtion of extra width in the strip between the vehicles as required by the vehicles themselves.

Comparison With Current Practice.—That we may compare the results by this method with current practice, Fig. 4 shows by curve the extra width required on the basis of a truck with two trailers on an 18 ft. pavement, the shaded area showing the "envelope" of practice shown in Fig. 1. It will be noted that in general the states require more width than necessary on flat curves and less than required on the sharp ones. Or, expressed differently, the recommended curve is nearly a straight line, while nearly all of the practice curves are decidedly concave downward.

Highway Traffic Surveys

Digest of Committee Report Presented Nov. 8 at 3rd Annual Meeting of Advisory Board of Highway Research

A traffic census will give information pertaining only to the traffic using the highway at the time the census is taken. A highway transport survey is to determine the probable amount and character of the future traffic which will use a given highway during the lives of its several component parts. No state has extensively taken up the highway transport survey.

After an extended highway traffic census, it is recommended that additional counts be taken at critical periods of the year in succeeding years from which, after a number of counts have been taken, curves of natural increase can be plotted from which can be roughly determined an estimate of increased traffic for a reasonable period of years. This estimate should also include the curve of increase of motor vehicle registration which can be determined at the present time in every state.

The value of an extended traffic survey is determining the allocation of construction and maintenance funds in the development of a highway system is unquestioned. Such traffic survey, however, should be utilized for type and strength of surface, rather than for location of expenditures inasmuch as the development of new territory within a state is as much a demand upon the expenditure of highway funds as the taking care of traffic already developed.

The personnel requires a certain amount of special training although courtesy has been found to be the largest asset. A special sign at the census station giving the reason for the questioning is the greatest factor in reducing the time required to pass a car or truck through the station.

A self-recording traffic counting and weighing device, to operate at minimum cost, is being developed.

A traffic census must include enough detail and be taken over an extended period of time so as to determine the seasonal traffic which varies greatly in certain parts of the country and which is a maintenance rather than a construction problem. The construction type must be based on the heaviest travel rather than on average or seasonal travel. A determination should also include the effect of slow moving vehicles upon the general situation and the consideration of the possibility of legislation which will remove such vehicles to secondary roads during high peaks of traffic to avoid congestion.

U. S. Personnel Classification Board Adopts the Bureau of Efficiency Compensation Schedules

Information just received from the federal secretary of the American Association of Engineers states that the personnel classification board, by a 2 to 1 vote, has scrapped the Sterling-Lehlbach plan of classification provided for in the Classification Act of 1923, passed by Congress on March 4, 1923, and has decided to classify the field as well as the District of Columbia employes in accordance with the Bureau of Efficiency compensation schedule, which was embodied in the Brown-Smoot bill, and rejected by Congress. On Nov. 13, 1923, the board issued a circular to all government department heads requesting gradings of field service positions in accordance with a suggested schedule of compensation, derived from the Bureau of Efficiency schedule.

Meeting of Iowa Engineering Society.—The 36th annual meeting of the Iowa Engineering Society will be held Jan. 29-Feb. 1 at Cedar Rapids, Ia. It was planned originally to hold this meeting one week earlier. Lloyd A. Canfield, 406 Flynn Bldg., Des Moines, Ia., is president.

The Problem of Highway Financing in America

A Paper Presented Nov. 6 Before the Annual Meeting of the Michigan Good Roads Association, Lansing, Mich.

By A. R. HIRST,
State Highway Engineer of Wisconsin

The American people are living through the greatest transportation miracle of all time without in the least realizing that the miracle is taking place; without computing the cost of it; and without computing the cost of supplementing it by another miracle just as astounding in its scope and magnitude. Not one in ten thousand has the slightest realization of the economic, social and engineering problems presented by these twin marvel episodes—the development of the motor vehicle and of a highway system to meet the needs of it.

America passed through its first episode of highway building from 1800 to 1830; through its great area of canal building from 1810 to 1840; its great era of railroad building from 1850 to 1880. Its second great era of railroad building commenced with faltering steps about 1890, attained some proportions about 1910, is now almost in full progress, with the probability that the major portion of the episode of constructing a modern highway system will take place between 1920 and 1940.

The Growth of Motorization and of Highway Expense.—The figures indicating the development of motor vehicles and of motor transport and the parallel development of highway construction and maintenance are so astounding that they have passed almost unnoticed. Even the statistics showing the progress of the motorization and of the highway enterprise have hardly keen kept. When one seeks to recover the facts of only a decade or two ago, he finds great difficulty in placing his hands on figures which are dependable. There are, however, available some figures which sketch the steps of the development of the motor vehicle and of highway expenditures in the last two decades with sufficient detail and accuracy for our present purposes. The four years were selected because the United States Bureau of Public Roads had quite carefully collected the figures of national highway expenditures for three of them, viz: 1904, 1914 and 1919. Further, 1904 marks about the end of the period before the modern motor vehicle and highways era; 1914 the first beginnings of a real American highway construction program; 1919 the resumption after the pause due to the war; and 1923 the well started modern highway program.

In 1904 there were in operation in America about 58,000 automobiles. There were practically no motor trucks. In 1914 there were registered 1,711,339 automobiles and motor trucks. In 1919 there were registered 7,530,105 automobiles and motor trucks. In 1923, preliminary figures indicate a total registration of at least 14,000,000 automobiles and motor trucks.

In 1923 the people of at least 40 American states own and operate more motor vehicles than there were in all of America in 1904. In 1923, in New York and California combined, or in Ohio and Pennsylvania combined, there are owned and operated more motor vehicles than there were in all of America in 1914.

In 1904 the rural highway expenditures of America are reliably computed to have been $59,527,000; in 1914, $240,264,000; in 1919, $389,456,000; and in 1923 they are estimated to be at least $800,000,000. Roughly, the rural highway expenditures per motor vehicle in operation in 1904 were about $1,026; in 1914, $140; in 1919, $52; and in 1923, $57. The expenditures per motor vehicle in 1923 were 5 per cent of those of 1904; 40 per cent of those of 1914; and 110 per cent of those of 1919.

Fourteen million motor vehicles in 1923! The investment of the American people represented in them is probably 10 billion dollars. The annual cost of owning and operating them was undoubtedly $5,600,000,000. This is nearly 2 billion dollars more than all taxes, exclusive of federal taxes, and over one-half of all taxes, including the federal taxes! They were operated a total of at least 56 billion miles. These last two figures, it will be noted, give 10 ct. per mile

as the average cost of operation, which is conservative.

If we could, through the development of a real system of highways, reduce the operation cost of motor vehicles 1 ct. per mile (and we can), the annual saving to motorists would be $560,000,000. This capitalized at 4½ per cent would represent an investment of about $12,500,000,000. This could be proven to be a profitable outlay on this one item of saving alone.

One filling of their fuel tanks, even at present prices, costs the proud owners about $27,000,000. If each should lose a casing and tube, the cost of replacement, at a weighted average of $20 each, would be $280,000,000.

The above paragraphs are written with the idea of showing the large figures which must be dealt with when we touch anything which relates to motor vehicles. This immensity must always be borne in mind when considering the problem of developing highways for motor transport.

We are not going to speculate very much on what may be the further development in the use and operation of motor vehicles. When the percentages of increase in the number of motor vehicles made and sold in the last two years are considered, it is quite sure that the end of motor vehicle increase is not yet near. At the end of 1916 there were 3,513,000 motor vehicles registered in America. At the end of 1923, 14,000,000. The numerical increase for the six years, 1917 to 1923, inclusive, was 10,487,000. It seems well within the bounds of probability that there will be a numerical increase of 6,000,000 in the six calendar years 1924 to 1930, inclusive, so that by the end of 1930 there should be owned and operated at least 20,000,000 motor vehicles. This naturally makes the problem of providing highway service for them loom even larger than the present registration figures indicate.

Even with the meager figures available, a paper of much more length than has been assigned this one could be prepared bringing out the twin wonders of motor transport and of highway development, but we must leave these interesting speculations to other times.

The Financial Problem.—It must be quite obvious from the above summary of the momentous developments in highway transportation in the las two decades that there has been pre cipitated upon the American peopl a problem of public financing un paralleled in the history of the na tion. Financing the public schools colleges and universities involve practically as much public money a highway work does. But the publi schools have been a process of slov development, speeded up, it is true by modern demands during the las two decades, but still a slowly develop ing growth of and from the basi American idea of free public educa tion. The machinery of school ad ministration is the growth of over a century. That the public schools mus be supported by the whole peopl largely in proportion to their wealt is established.

The problem of highway financing has been forced upon us almost ove night due to the unparalleled demand for transportation service and fo highways. Taxation for highways i America for 1904 was practically negligible factor in the total taxation In 1923 it has reached such propor tions that in many states it is nearl one-half the total tax bill of all unit of government. Obviously, such a unexpected and unwelcomed increas in the obligations of government mus demand especial consideration an special treatment.

It is not as if the other obligation of government were being reduced It is not as if other public or privat expenditures of the American peopl were being reduced. The cost of ou government service to water born transportation is not decreasing; th cost of our railroad service is not de creasing. "On the contrary," as th polite Frenchman replied when aske on a rough morning on shipboar whether he had breakfasted. In addi tion to all of these former costs o transportation, we are in the midst o a most wild and exotic growth in th amount expended for personal trans portation and in road service to tak care of this increase in personal trans portation.

We have stated that the cost to th American people of owning, operatin and depreciating motor vehicles i 1923 was at least $5,600,000,000. Thi is in addition to the cost of construct ing and maintaining highways an bridges in all units of governmen which must have been $1,000,000,00

There are offsets to this new bill in that there are more people to be served with transportation, probably less expenditure for transportation by horse drawn vehicles, and a greater volume of goods to be transported. But, it is an increase of at least $6,000,000,000 in our annual bill for highway transportation—largely for added highway transportation for persons—over the bill of 1904.

Wether the American people can afford each year to expend 6 billion dollars more for highway transportation than they did in 1904, we will not discuss. We will discuss the rural highway bill of America for 1923 as compared to the rural highway bill of 1904. The bill of 1904 was $59,500,000, and of 1923 is $800,000,000. The difference is $740,500,000. In general, the only difference between the highway conditions of 1904 and of 1923 is that in 1904 there were practically no motor vehicles, and in 1923 there are 14,000,000 of them. The change in the situation has been brought about almost wholly by the astounding increase in the transportation of persons and goods by motor vehicles. The increase in the cost to government, due to the American people's possession of motor vehicles has, therefore, been for rural highways alone (disregarding the very largely increased costs improved upon the cities and villages) approximately $740,500,000.

In 1904 the motor vehicle paid toward the cost of highway work in America practically nothing. In 1923 the taxation upon motor vehicles other than the government luxury tax, which has no bearing upon the financing of highway work, is probably $300,000,000. Of this probably $100,000,000 is paid as a personal property tax net dedicated for use on highways, while $200,000,000 is probably paid in license fees, franchise taxes, gas taxes, etc., the proceeds of which go largely to highway uses. In other words, as an especial class of property signally benefiting from highway development, the motor vehicle is taxed for the construction and maintenance of highways in 1923 approximately $200,000,000. This is 3.6 per cent of the total cost of owning and operating them in 1923. Disregarding as negligible the taxation on motor vehicles for highways in 1904, it is $200,000,000 more than they paid in 1904. The increase in the rural highway bill between 1904 and 1923 is above shown to be $740,500,000. Therefore, the motor vehicle is charged in taxes, paid due to its use of highways and not due to its existence as a luxury or to its existence as a piece of personal property, about 27 per cent of the additional cost of constructing and maintaining rural highways imposed upon government by its ownership and use. Please, again, remember that the added costs (and they are great) imposed upon cities and villages by motor vehicle ownership are not included in the above figures.

Who Shall Pay the Highway Bill?—Of course, those who believe that the motor vehicle is already overtaxed will contend that other causes have led to the increase in the highway programs, but this other urge has been so small as to be negligible. In a broad summary, such as this, we are certainly justified in saying that the increase in the American highway program of today over that of 20 years ago is caused by the ownership and use of motor vehicles. We know that every plan for highway construction or maintenance; every relocation; every bridge design; every plan for highway systems and layouts; in short, every highway problem of nation, state, city and county originates with and has its conclusion drawn from a study of the present and future demands of motor vehicle traffic.

In national, state, county, or city legislative bodies or highway organizations there is no discussion of roads, streets or bridges which does not hinge on the necessities of the motor vehicle. The horse and the horse drawn vehicle has practically disappeared from consideration and in not one phase of modern highway development does the presence or the absence of the horse have any real bearing. In 99 cases out of 100, horse drawn traffic is given as little consideration as is the number of dinosauria and mammoths who may traverse the highway. We are motorized people, dealing with a problem of motorized transport, and commencing to pay the bill for motorization.

It is also urged by the opponents of further imposts upon motor vehicles that other property and other persons are also benefited by the development and maintenance of highways and should pay their part of the cost. We

would be the last one to deny that every person, every business, every piece of real property, every social and business activity does benefit and benefit greatly from the development of highway systems. We would be the first one to say that they should pay and pay to assist in the development of highways. But other property and incomes have all other governmental activities to support and they cannot be bankrupted for highways. They must help to pay, but after they have paid for highways all that can, with any equity, be imposed upon them, there remains a large bill which cannot be paid by property or by incomes, but which must be paid by the motor vehicle. There will be paying enough to go around so that none will feel slighted.

The motor vehicle propagandist then avers that the amount of the bill to be paid by the motor vehicle should be the cost of maintaining highways, and that the motor vehicle should pay no part of the cost of the construction enterprise. How this remarkable conclusion was first arrived at we are unable to determine. Certainly it should be included and enshrined among the most laughable jokes ever sought to be seriously presented to the attention of the American public. "Life" never printed anything half as funny. If carried to its logical conclusion, this masterpiece of economic thought means, of course, that the poorer the roads of a state, the more the vehicle owners of that state should pay—the better the roads, the less they should pay.

Under this wonderful theory, for instance, a state having a 10,000-mile road system to construct might determine to construct it of cement concrete at an average cost of $40,000 per mile. The total cost would be $400,000,000. "This, property should pay!" The cost of maintaining this system, when fully built, would be about $3,000,000 per annum. "This, the motorist should pay!" On the other hand, the state might determine to build the system of gravel and other inferior surfacings at an average cost of $10,000 per mile. The cost of the system would then be $100,000,000. "This, property should pay!" The cost of maintenance would be about $10,000,000 per annum. "This, the motorist should pay!" The motorist should pay 7 million dollars more per annum for a road system of inferior value and economy tha he should pay for a system of road conceded to give better and more eco nomical service to motor transporta tion every day in the year! Is it no astounding that men, usually quit sane, seriously claim that this is com mon sense and correct economics?

Proportions to Motorists and t Other Property.—Is there any meas ure of the proportion that motorist should pay of the cost of the highwa program of a state? No measure ha so far been established. The problen has come upon us so suddenly, s much of the reasoning upon it ha been wild and unfounded, that Ameri can thought has not even begun t crystalize upon any basic measure ment of what the motor vehicle shoul pay.

We have had, of course, the scal of fees in the "proposed uniform ve hicle license law" urged as a panace by the National Automobile Chambe of Commerce. This was propose several years ago as fair taxation bu died before it was hardly born. A far as we known, no American stat ever adopted it, and we venture t predict that no American state eve will. Its scale of fees is unscientific unfair, and far too low, and has valu merely as a matter of history.

We claim that there is only on measure of what the motor vehicl owners should pay, viz:

The total sum paid for highwa service by the motor vehicle owner of a state should be measured by th benefits the motor vehicle owners o the state receive from the state's pro gram of highway construction an maintenance.

This should be quite obvious. A tax collected should represent serv ices rendered or to be rendered an benefits received or to be received. I great services and benefits are give the owners of motor vehicles in a give state, the charge which that stat should make on them can legitimatel be much higher than the charge which should be made by a state whic gives few benefits and offers littl facilities for travel.

If the reader will compare state with the roads of which he is familia it is believed that he will assent to th proposition that taxation upon moto vehicles should not be uniform, wit all motor vehicles of like kind payin the same tax in every state. He wi

agree that proper and fair imposts upon motor vehicles will vary with the states, and that the motor vehicle owners of different states should pay and should be willing to pay different sums, varying with the highway facilities offered them by their state and county governments. Does the "proposed uniform vehicle license law" meet these conditions? Naturally, it does not.

A Proposed Guide to Judgment.—We are going to venture to give what we believe is a formula by which there can be determined the sum which the motor vehicle owners of a state should annually pay toward its highway program, in payment for benefits they receive from the program. By the highway program of a state, we mean not only the program of the state itself, but also of all units of government in the state, including its cities.

"The Hirst Formula."—The motor vehicle owners of each state should each year pay for their highway service one-half of the total amount made available in that year to pay the cost of the state's highway program, after deducting from said amount the total amount made available to pay the cost of the state's highway program in 1904.

Nineteen hundred and four is selected as the basing year because quite dependable figures of highway expenditures in all states are available for that year, and because it quite accurately marks the real beginning of the motor era.

Please again read the formula before condemning it, and note especially that its terms do not include the expenditures made in any year from the proceeds of bond issues, but only the portion of the cost of bonding paid in that year.

Applying this formula to a hypothetical case; in a certain state there was made available in 1904 to pay the cost of all highway work, $10,000,000. There is to be made available $40,000,000 in 1925. The amount the motor vehicle owners should pay in 1925 is one-half the difference or $15,000,000.

The formula means that there would be paid by property and from other sources of governmental incomes:

(a) The total cost of highways which they paid at the end of the era of horse drawn transportation.

(b) One-half of the additional highway cost imposed upon government by the ownership and use of motor vehicles.

It, of course, means that the owners of motor vehicles would pay: One-half of the additional highway cost imposed upon government by his ownership of motor vehicles.

This does not seem to us to be unfair to the motorist. If there is any unfairness about it, property other than motor vehicles is probably paying, to say the least, a good full price for the general benefits and advantages incident to highway improvement. Translated into national figures, the formula means that based on total highway expenditures of $200,000,000 in 1914 and of $1,000,000,000 in 1923, the motorist should have paid $400,000,000 in 1923 for use on highways, not including the luxury tax and the personal property tax, neither of which is a tax for highways. This compares with the actual payment of $200,000,000, and means that they should have paid $200,000,000 more than they did pay in 1923, or approximately $14 more per motor vehicle, on the average.

We expect that many will oppose any proposed application of the formula to specific tax problems. We do not claim that it is perfect. In meeting especial conditions in certain states its arithmetical result would have to be modified by the application of common sense. We do claim, however, that it is of value as a guide to judgment. We do claim that it is the first mathematical formula proposed that recognizes the existence of the fundamental facts which should largely determine the relative part of the cost of highway programs to be paid by motor vehicle owners as such, and by other taxpayers as such.

Apropos to opposition to new ideas as to taxation, Macaulay in his great History of England, in discussing the new highway taxation imposed there in 1685, characterized the public attitude on the new taxes in language just as good and true now as it was when Macaulay wrote it in 1846. We quote him:

"A change was at length effected, but not without much difficulty. For unjust and absurd taxation to which men are accustomed is often borne far more willingly than the most reasonable impost which is new."

Present Systems of Taxation

We will now briefly summarize and comment upon the various common forms of taxation upon motor vehicles.

Valuation Taxes.—We believe that there should be a valuation tax upon motor vehicles if there is to be a valuation tax upon any class of property. Of course, if the theory of collecting taxes upon the basis of the valuation of property is wrong, then a valuation tax upon motor vehicles is wrong. Vice versa, if the valuation theory generally held is right, then the collection of tax based upon the relative valuation of motor vehicles is right.

The more expensive automobiles are owned for the same reason that the more expensive homes are owned; that is, because the owner believes that they repay him for the added investment and the added running expense in style, comfort, economy and convenience, or in the ability of himself and his family to enjoy life. If he really believes these things are true, he should be willing to pay additional personal property taxation, just as he is willing to pay an additional price to own and operate the more expensive house or motor vehicle. It should be recognized, however, that a valuation tax on motor vehicles is not a highway tax, but a property tax.

Horse Power Taxes.—Many states license motor vehicles upon the basis of horse power. We can think of no physical attribute of a motor vehicle which bears so little relation to the destructiveness of it as does its horse power. Horse power bears little or no relation to the speed, the weight, the value, or the use of a motor vehicle. There are at least 32 passenger car models on the American market which have the same or less horse power than the Ford. These 32 models weigh from 1,600 lb. to 3,500 lb. and retail at from $500 to $2,500.

Licensing by Weight.—This system somewhat classifies the relative destructiveness of various cars as between themselves, and of motor trucks as between themselves and as distinguished from automobiles. Weight has also some relation to value, but only when the vehicles are new. If there is to be a graduated classification of cars for the purpose of licensing them, their weight is the best factor. We believe there should be such a classification.

"Police Power" Licensing.—This is a necessity. The cost of the licens plates, licensing and of proper moto vehicle policing should be included i the weight license fee and collecte at the same time.

Franchise Taxes, Wheel Taxes, Etc —Some states still permit units o government smaller than the state t make charges upon motor vehicles i addition to taxing them as persona property. We believe that suc charges should not be allowed to b made, but that the full charge for th use of highways should be impose and collected by the state. Outsid of the debatable federal luxury ta now in effect, we believe that the fed eral government should not tax moto vehicles. If everyone around th farm milks the farmer's cows when ever he feels like it and uses the mil for all kinds of purposes, the farmer' monthly check will be much reduced Besides, the herd would develop a extremely nervous and irritable dis position.

The amount which the motor ve hicle owners should pay for highwa service is a thing individual to eac state. It should be determined upo by the legislature of the state as result of the most mature delibera tion. Simultaneous increases made b several units of government might, i permitted by law, seriously embarras the motor vehicle owners and th motor vehicle industry.

The states are the best and shoul be the only collectors of imposts fo highway service made upon motorists If the division of responsibility fo the main highways is such as to mak it advisable, there should be dis tributed to the counties a part of th proceeds. The state and county high way programs in every state shoul and will consume all that the motoris should fairly pay toward the highwa program. The lesser units of govern ment, such as townships, cities, an villages, should be content to see th state and county taxes on propert for highways reduced by larger col lections from motor vehicles. Thi will enable them to increase thei charges upon property for strictl local purposes, including local high ways.

The sum which can fairly be col lected from motor vehicle owners ha a maximum. If the federal govern ment takes a share and the loca municipalities take a share, the stat and county share will be so much th

ss. Necessarily the state and coun-es must make up the deficit by im-osing direct taxes upon property or taking a larger share of income xation. This simply complicates e situation without changing the al results as to the total taxes paid the various classes of property.

Motor Fuel Taxes.—The motor fuel x, commonly known as the gas tax, our opinion, is by far the most ientific impost upon motor vehicles. meters highway service and the nefits received from the use of high-ays. It approximates toll gate re-lts without the infirmities of toll te procedure. The consumption of soline varies with the weight, the eed, and the mileage of the motor hicle. No other factor in the car's mestic economy reflects so closely e benefits received from highway e.

It has been suggested that a tire x would be just as good as a fuel x. This might be true if it were t so easy to mail or ship tires, but e fear that if a tire tax were in fect the business of every tire aler would be with the people of her states. This would be unneces-rily expensive and cumbersome and eld no tax revenue to anyone. On e other hand, gasoline is bought ually from day to day, is best ught in that way, and can thus be ndled more cheaply and more safely an if shipped and stored for indi-dual use.

Objection is made that the worse e road, the more fuel consumed, and e more tax paid. This objection can-t be met by any argument which can devise except that as highway nstruction proceeds, the mileage of ad that this objection applies to will come less and less. It is the only actical objection ever urged against e fuel tax, and objections equally lid can be urged against any tax er in effect or ever proposed.

States can adjust ad infinitum ense fees fixed by the horsepower, eight or valuation of motor vehicles, by any combination of these fac-rs. They can probably attain some irness in the relative fees to be paid the different kinds of cars and ucks. It can be determined that a rd should pay so much, a Cadillac much, a five-ton truck so much. e relation thus established between em may be fair. But how about the relation between the Ford which travels 2000 miles and the Ford which travels 15,000 miles—the Cadillac which travels 5000 miles and the Cadillac which travels 40,000 miles—the five-ton truck which travels 5000 miles, and the one which travels 25,000 miles?

If the relative use of highways by various motor vehicles is to be included as a factor in determining the highway tax to be paid by the motorist, then the motor fuel tax must be in effect as one factor in the total imposts. It is the only practical way to collect impost which marks relative highway use and the relative benefits therefrom.

We believe that many states will find it necessary, at least during the coming heavy construction period, to impose fuel taxes of about five cents per gallon. States which have been extremely backward in highway development may have to collect as high as ten cents a gallon. We believe it will be usual to exempt fuel used other than in highway transport from paying the tax. This will cause some abuses, but there are abuses in every tax system. As soon as motor fuel taxes of quite uniform amount are in effect in every state, practically every objection to the gas tax will have been eliminated, and a method of highway taxation and of highway financing will have become universal which is as nearly in accord with the equities in the case as human ingenuity can devise.

Conclusion.—It is impossible in the compass of a thirty minute discussion of highway financing to more than briefly touch some of the high spots. We have tried briefly to paint a picture of the situation, with no greater hope than that we might start further and much more effective discussion of this major problem of the American people.

It seems absolutely certain that the American people must spend in the next twenty years in the development and maintenance of their highway systems, both rural and urban, a sum approximating twenty billions of dollars. This must inevitably be true, unless the American people not only do not increase, but, on the contrary, greatly reduce their present use of highways for transportation. It is equally true that we are facing a financial enterprise and an engineering enterprise far surpassing any

previous public enterprise except that involved in the prosecution of the late war.

These things being true, it must be quite obvious that, inasmuch as there appears to be no prospect of a reduction in the standard of American living or in the public expenditure for education, parks, water supply or public health, we must look to and develop new sources of revenue for the payment of a considerable share of the cost of this new highway enterprise. It appears to us that this source of very materially increased public revenue must be the motor vehicle, the thing which largely sets our scale of highway expenditure, the thing which benefits most from the expenditure.

If we are to get very far with this line of thought, we must divorce from our minds the idea that imposts upon motor vehicles for use in building and maintaining highways are, properly speaking, taxes. They are not taxes. They are just the remainder of the bill due to our ownership of motor vehicles.

One buys a motor vehicle. He pays the price and owns the vehicle. If one is to get any use of it, he must buy fuel to propel it, oil to lubricate it, he must replace worn and broken parts and the tires as they become useless. The cost of these are a legitimate part of the cost of owning and operating a car. We do not consider it robbery when a tire man charges us twenty dollars for a casing, or a gas man two dollars for a filling of gas. We regard the owner of the tire shop and of the filling station simply as merchants selling us a commodity which we must have in order to operate our car, so that it may return us dividends, either in money or pleasure, or both.

In exactly the same way we must buy our highway service from the state. Highway service is just as essential and is just as much a part of the legitimate cost of operating a motor vehicle as is anything else that must be bought if we are to operate it with economy and efficiency. A fair charge by the state for this service is not robbery, murder, or arson. It is just as cleancut and defensible a business deal as is any other business deal connected with the purchase and operation of a motor vehicle. We pay a fair charge made by government for a commodity — highway service— which, as motor vehicle owners, w must have. Probably we will get ou of our payments to the state a greate return than we get out of any so called private business deal incider to our ownership of a motor vehicle.

We must brush our brains clear o cobwebs, obsessions, prejudices an bunkum, and calmly recognize tha when we bought and insist upon oper ating fourteen million or more moto vehicles, we bought also a highwa expenditure of billions of dollars, jus as much a part of the cost of thes motor vehicles as are themselve their tires, their engines, and thei supplies. They go together, the moto vehicle and the highway on which i must run. All the costs must be paid

When the American people come t this only sane viewpoint, it will b possible to rapidly develop the re quired highway systems. If the moto vehicle is to be soon fully served, i it is to become in our time an instru ment of transportation operating, i fact, with something like one hundre per cent efficiency three hundred an sixty-five days in the year, we mus invest billions in highways, and th owners of motor vehicles must pay fair share of the bill.

In our own state, and elsewher we have been sometimes indicted a an enemy to the motor vehicle indu try and to the motorist, because w have insisted that the motorist mu pay adequately if he wished econom cal highway service. Whether or n we are or have been an enemy to th motorist we are unable to prove. W have spent twenty years in this ro game but neither our enemies nor o friends can now fairly judge us. R sults and highway history will do th in due time.

We do still insist that the motori must pay—adequately, largely—a most until it hurts. Building a mo ern American highway system, co prising at least five hundred thousa miles of road, in two or three decad is not child's play. It is an ente prise of appalling magnitude. It c be done, it will be done, because wh the American people need or ev wish for anything they get it. Th not only wish for highways, they ne them, and they will get them. B they must pay the price—and t principal user of the road, the moto ist, cannot escape almost scot fr from the paying!

Notes on Highway Maintenance

Digest of Committee Report Presented Nov. 8 at 3rd Annual Meeting of Advisory Board of Highway Research

Corrugations form in all gravel roads when the traffic becomes excessive, probably 500 or 600 vehicles per day. Their formation is in no way dependent upon construction or maintenance methods. Corrugations are most apt to occur on flat grades. They are caused by displacement of the material due to the spin of the drive wheels, and by impact of the wheels both front and rear after a bounce. Dragging with heavy equipment after a rain is a temporary corrective.

Maintenance of gravel road surfaces with a mulch treatment of gravel is giving good results on light traffic roads. The treatment consists of keeping a light application of loose, clean gravel, up to ¾ in. size, on the surface of the road.

A light color of the filler used for joints and cracks in concrete pavement is no longer considered essential. Experiments are being conducted with various grades of tar and asphalt for fillers.

Every state should adopt a distinctive symbol for its route markers.

Warning signs should be uniform in all states and should not be used except where necessity is obvious. Shape, color, size and location recommended in report.

All advertising signs should be forbidden on the highway right-of-way.

Expenditures by the states, through their maintenance organizations, shall be classified in their annual reports for purposes of uniformity and comparison, as follows:

1. Maintenance administration
2. Maintenance proper
3. Additions and betterments
4. Parks, camping grounds and roadside beautification.

The last three classifications shall be charged to a specific section of road.

Additions and betterments shall include expenditures for the increased permanent value of the road to accommodate traffic. This will include the cost of:

1. Increased width of surface or roadbed
2. Increased depth of wearing surface over any previous maximum depth
3. New guard rails
4. New walls
5. New drainage structures and water courses
6. New subdrains
7. Improving grades, alignment and vision.

A Suggestion for Road Patrolmen

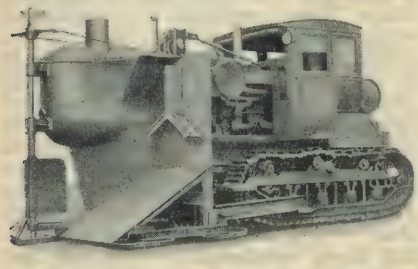
From the September Service Bulletin of the Iowa Highway Commission

It is ridiculous for a road patrolman to ride up and down the good portions of his road and scrape and blade these sections to perfection while mud holes and ruts mark up the other parts of his patrol section. It is not good practice to give bad sections of the road no more treatment than the good sections just because it might require turning the equipment around several times in order to put the bad stretch into shape. Turning around, it is admitted, is harder work than sitting on the machine and riding along comfortably from one end of the section to the other. It is service which the road builder and maintainer is paid to give to the traveling public. The traveling public is paying the bill in cash out of pocket and the man paying the bill for service wants that service for himself now and not tomorrow, next week, next month or next year. He is not paying for service for his children or those who come after him or even for service when he himself is ten or twelve years older. What the user of the highway wants today and now is a smooth surface to drive his car over. He wants the entire road smooth, not a rut or rutty section for every hundred or two hundred yards and then the road smooth as a billiard table for several miles. The only way he can get what he is paying for is for the man who is hired to maintain the road to go over and over the bad spots until they are in condition and approximately equal in driving surface to the balance of the road. It certainly is not good judgment or satisfactory service for the man in charge of a maintenance outfit to ride up and down the smooth parts of his patrol section utterly neglecting bad spots or at least giving them no more treatment than the section which are already in good condition.

Twin Rotary Snow Plow

For cases where depth of snow or other conditions prevent the satisfactory use of blade or "V" type plows, the Monarch Tractors, Watertown, Wis., have brought out the rotary plow here shown. Development of this machine under direction of Mr. A. B. Webb, chief engineer for the makers, covered a period of more than three years, so that the design had received a thorough working test before being placed on the market.

The Monarch twin rotary snow plow weighs about 4,500 lb., is 8 ft. in width, and is a self-contained unit, powered by a Beaver heavy-duty in-



Monarch Twin Rotary Snow Plow.

dustrial motor. The two heavy steel fans are driven at a speed of about 350 r. p. m. Each fan can be disconnected independently by means of a twin disc clutch. The fan runs on heavy Timken bearings and the whole construction is strong and simple. The front shoe and rudder are designed to assist in steering, but the plow can be controlled easily by the tractor through heavy oscillating push bars attached to the crawlers. Movable vanes around the fan control the height and distance at which snow may be thrown.

Industrial Notes

The Weller Manufacturing Co., manufacturers of elevating, conveying and power transmitting machinery, Chicago, announces the following new offices: Stratton-Cahoon Co., 809 McIntyre Bldg., Salt Lake City, Utah, to look after the sales in the northwest territory. To take care of their trade in the Omaha territory, the company will open a sales office at 627 Grain Exchange Bldg., Omaha, Neb. O. F. Barklage of the Industrial Sales & Engineering Co., will be in charge.

Donald M. MacNeal, formerly with MacArthur Bros. Co., contractors, and for 5 years associated with A. L. Torbart, has opened offices at 166 W. Jackson Blvd., Chicago, where he will engage in buying and selling construction equipment.

The Heil Co., manufacturers of dump truck bodies, hydro hoists, tanks, etc., Milwaukee, Wis., announces the appointment of two new distributors: the Kranz Automotive Body Co., Gravois at Minnesota, St. Louis, Mo., has been appointed the Heil Co. St. Louis territory distributor. The Shop of Siebert, 614 Southward Ave., Toledo, O., is the other new Heil distributor.

Chain Belt Co., Milwaukee, Wis., manufacturers of Rex chain, transmission machinery and conveying equipment, formerly represented on the Pacific coast by Meese & Gottfried Co., San Francisco, has established direct factory branches and warehouses in Portland and Seatle. Arrangements have also been made with the Washington Machinery Depot, Tacoma, Wash., to carry a large stock of Rex chain and transmission machinery. Other stocks will be placed in important centers throughout the Pacific Northwest for the prompt handling of local requirements. The northwest territory, with headquarters at Portland, will be in charge of Allen C. Sullivan, M. E., a graduate of the University of Washington. Don B. Catton, formerly with Meese & Gottfried Co. and later engaged in the machinery supply business on his own account, will be the special sales representative for the Portland office. The Seattle and British Columbia territory will be handled by Wm. F. Nichols out of the Seattle office. Mr. Nichols for the past 11 years has been connected with the Meese & Gottfried Co. The Portland office of the Chain Belt Co. is located at 67-69 First St., Portland, Ore., and the Seattle office at 1040 Sixth Ave., S., Seattle, Wash. Large stocks are maintained at both places.

The Blaw-Knox Co., manufacturers of road building machinery, buckets, forms, etc., Pittsburgh, Pa., announces the opening of a Buffalo, N. Y., office at 622 Genesee Bldg. J. C. McQuide has been transferred from the Pittsburgh organization as manager of the Buffalo office. The Buffalo office will now serve northern and western New York and adjacent territory.

W. & L. E. Gurley, manufacturers of engineering instruments, Troy, N. Y., has established an office at 364 Monadnock Block, 53 W. Jackson Blvd., Chicago, Ill. Delivery of transits, levels, plane tables, rods, water stage recorders and current meters can be made from this office. C. H. Smart is Chicago representative.

The Pawling & Harnischfeger Co. of Milwaukee, Wis., manufacturers of excavators, cranes and machine tools, has recently appointed R. P. McCormick as its eastern sales manager, with headquarters at 50 Church St., New York City, and 605 Stephen Girard Bldg., Philadelphia.

The Little Red Wagon Mfg. Co., Omaha, Neb., has purchased the business of Stroud & Co., Omaha, and will continue the manufacture of Stroud elevating graders, Stroud Little Red Dump Wagons, Stroud road maintainers, scrapers, drags, plows and other road making machinery. The new organization will continue the Strouds parts service.

The Board of Directors of Underwriters' Laboratories announce that at a special meeting of the board, held Nov. 10, Dana Pierce was elected president of Underwriters' Laboratories. A. R. Small was elected vice-president. D. B. Anderson and L. B. Headen continue as secretary and treasurer, respectively.

Water Works

1223

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.
221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*
LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 904 Longacre Bldg., 42d St. and Broadway
RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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Vol. LX. CHICAGO, ILL., DECEMBER 12, 1923 No. 6

Typhoid Progress

For the past two weeks or more typhoid fever has existed in Chicago in amounts sufficient to attract much attention in the press and elsewhere. As this is written the report for the preceeding day gives a total of 173 cases, the most of any day since the outbreak.

Yet less than a generation ago, and when Chicago was much smaller than now, this same number of cases would have been an entirely ordinary occurrence. Typhoid reports from the districts served by the various pumping stations then formed a part of the daily news. Many people boiled their water if the health department reported bad conditions in their district. The more careful boiled their water at all times or bought drinking and culinary water from pure sources.

The source of the present "epidemic" has not as yet been determined, and it may not even be connected with the water supply. Furthermore, although the epidemic attracts attention, it causes no general concern: no one doubts that it will be kept within narrow bounds and will be speedily stamped out.

All of this again reminds us that here is a disease, the conquest and continued subjection of which is due to the engineering rather than to the medical profession. Medicine, it is true, has contributed honorably to the work, but its part has been a minor one.

Chicago, always dependent on Lake Michigan for its water supply, reached with its intakes farther and farther into the lake as contamination from the shore increased. These extensions to more remote and deeper water mitigated but did not extirpate the contamination. The next great steps were the reversal of flow in the Chicago River and the construction of the drainage canal, thereby diverting all of Chicago's sewage from the lake and leaving only that contamination which is unavoidable along a busy and densely populated waterfront. This drainage made a vast improvement in

health conditions, but it was not until the introduction of the liquid chlorine treatment, about a dozen years ago, that the entire water supply was made practically free from disease germs.

Here is a record of which the engineering profession may be proud indeed. A community whose growth continually outstripped expectations, located on topography difficult of drainage, and with the natural drainage all directly into the only practical source of water supply, is freed from water borne disease by a series of bold and intelligent steps, all within the memory of an ordinary lifetime. In retrospect it is inspiring. In prospect it took vision and courage.

The Electrical Advance

In our issue of Aug. 8 we published a paper by Mr. F. H. Bushnell entitled "Higher Steam Pressures and Improvements in Station Economy," in which the author discussed current experiments in the use of steam pressures of from 1,200 to 3,200 lb. per square inch, and what appeared as a reasonable expectation of obtaining a kilowatt hour of electrical energy for 1 lb. of coal burned. In the same issue we commented editorially on this matter and added a reference to the possibilities of increased fuel efficiencies through the use of two different evaporating liquids, such as mercury and water, now being tried out at Hartford, Conn., and water and carbon disulphid, which combination is reported in successful use in Germany.

Thirty years ago the best electric generating stations were burning 4 lb. of coal per kilowatt hour produced. Commenting upon the mercury and high pressure steam experiments, the Stone & Webster Journal for November contains the following:

> The unit has been in operation and the indications are that, aside from troubles always incident to experimental installations, the results are going to be satisfactory.
>
> The unit is a boiler which vaporizes mercury. This vapor drives a turbine and is then exhausted into a boiler which condenses it to a liquid and at the same time converts the cooling water into steam, this steam passing through another turbine and being condensed by water in the usual way. It is expected that this combination of processes will reduce the coal consumption of a generating station by about one-third.
>
> The investment will be comparatively heavy per unit of capacity, but even after allowing for this there will be a substantial reduction in over-all power costs if present expectations are realized.
>
> This mercury turbine is merely one example of pioneering and progress. The Edison Electric Illuminating Company of Boston is pioneering along slightly different lines. In a station now under construction Stone & Webster are installing for them auxiliary turbines which take steam at a pressure of 1,200 lb. to the square inch, exhausting into the main steam line for the principal units, which will operate at 375 lb. pressure.
>
> The Boston Edison Company expects to produce a kilowatt hour for one pound of coal; that is, we will get four times as much power from a ton of coal as we did 30 years ago.
>
> In lighting, the change from the carbon lamp to the tungsten was an important step, and now has come the nitrogen lamp, and we are getting four times as much light per kilowatt hour as we did 30 years ago. Combining the improvements in generation and in use, we get 16 times as much light for a pound of coal.

Thirty years ago electric lighting was a well accomplished fact; electrical science and industry were considered as infants of great promise; but there was no anticipation that fuel efficiency as applied to lighting would be increased 16 times.

Before us today is the problem of electric heating—as yet unsolved except for certain minor uses, where a comparatively small excess of cost is more than offset by the conveniences afforded. The editor admits that he sees no prospect of improvements making possible the extensive use of electricity for heating buildings, yet he is furthest from denying that the accomplishment may be wrought. The hot air furnace, the individual steam or hot water heating plant, the stove, are less efficient in extracting heat units than is the great central plant. The prohibitive loss is in getting the units from plant to consumer and into the latter's use. But, are we of today any more warranted in denying its possibility than were the engineers of a generation ago in denying that there could be a vast increase of efficiency in converting a B. T. U. into electric light? At present the heating device is the weakest link in the efficiency chain, and we see no prospect of greatly bettering it. Yet improvement may come, and it need not of necessity approximate to 100 per cent efficiency. Let the improvement but reach a certain point, and be supplemented by a further increase in power plant efficiency and further reductions in transmission, conversion and distribution losses, and it may be cheaper to burn our coal in great central plants (probably located at the mine mouth) than in the furnaces of our own homes and business houses.

Water Works and Sewer Contracts Awarded During the Last 46 Months

The accompanying tables show: First, that the waterworks and sewer contracts awarded during the last half of each year exceed in volume those awarded during the first half; second, that there is not a month in the year without a very large volume of waterworks and sewer contracts; third, that each year shows a gain over its predecessor in the volume of contracts awarded in this "hydraulic field."

The volume of irrigation and drainage contracts will surprise any one who has not followed closely statistics of this sort.

WATERWORKS CONTRACTS EXCEEDING $25,000 IN SIZE.

	1920	1921	1922	1923
January	$ 1,144,000	$ 519,000	$ 1,727,000	$ 4,720,000
February	2,172,000	2,927,000	652,000	2,730,000
March	2,213,000	2,028,000	1,093,000	15,149,000
April	2,719,000	3,342,000	2,673,000	8,544,000
May	1,382,000	4,944,000	3,568,000	7,329,000
June	1,461,000	3,485,000	5,124,000	4,045,000
July	3,793,000	3,106,000	811,000	3,803,000
August	775,000	2,404,000	4,494,000	3,678,000
September	743,000	1,487,000	3,906,000	2,881,000
October	11,169,000	900,000	7,686,000	3,636,000
November	2,151,000	4,698,000	2,161,000	.....
December	1,051,000	10,752,000	1,835,000	.....
Total	$30,773,000	$40,602,000	$35,730,000	.....

Note.—About 100 per cent must be added to the annual totals to give the grand total of contracts awarded in the United States.

A great deal of waterworks construction is done by directly hired labor and is not included above.

Waterworks buildings are not included above.

SEWER CONTRACTS EXCEEDING $25,000 IN SIZE.

	1920	1921	1922	1923
January	$ 1,864,000	$ 3,147,000	$ 2,267,000	$ 3,322,000
February	623,000	2,445,000	2,462,000	2,131,000
March	1,283,000	2,862,000	3,796,000	4,477,000
April	4,124,000	3,817,000	2,794,000	5,497,000
May	2,315,000	2,162,000	5,722,000	9,052,000
June	2,349,000	3,802,000	5,158,000	6,501,000
July	3,163,000	3,986,000	1,869,000	3,183,000
August	2,437,000	3,988,000	3,450,000	13,753,000
September	2,319,000	5,064,000	3,340,000	10,368,000
October	3,052,000	2,829,000	4,996,000	5,096,000
November	4,572,000	2,733,000	5,349,000	.....
December	2,967,000	2,549,000	2,381,000	.....
Total	$36,068,000	$39,384,000	$43,584,000	.....

Note.—About 100 per cent must be added to the annual totals to give the grand total of contracts awarded in the United States.

A considerable amount of sewer construction is done by directly hired labor, which is not included in the above totals.

IRRIGATION, DRAINAGE AND EXCAVATION CONTRACTS EXCEEDING $25,000.

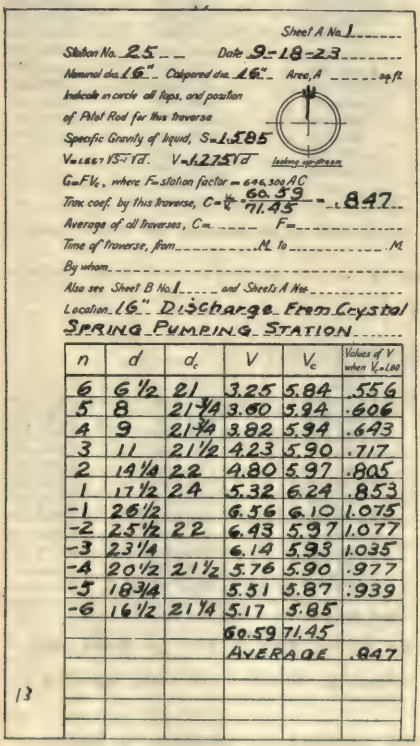
	1920	1921	1922	1923
January	$ 1,542,000	$ 1,266,000	$ 2,091,000	$ 548,000
February	787,000	306,000	419,000	365,000
March	3,151,000	1,626,000	608,000	28,993,000
April	416,000	580,000	1,736,000	2,506,000
May	404,000	2,632,000	776,000	3,553,000
June	605,000	1,240,000	2,628,000	1,174,000
July	1,942,000	609,000	1,498,000	6,902,000
August	4,179,000	89,000	6,920,000	2,337,000
September	859,000	9,025,000	876,000	3,360,000
October	1,086,000	373,000	2,390,000	874,000
November	772,000	726,000	1,741,000	.....
December	477,000	707,000	864,000	.....
Total	$16,220,000	$19,179,000	$22,547,000	.....

Note.—About 100 per cent must be added to the annual totals to give the grand total of contracts awarded in the United States.

A Simple Method of Determining Pump Slippage

By J. F. PIERCE,
Assistant Engineer, Roanoke Water Works Co., Roanoke, Va.

One of the great problems that faces most every water works official today is in determining the actual amount of water pumped. The customary method has been, and in a great many plants still holds true, to multiply the number of strokes, as recorded by the counter, by the number (theoretical) of gallons displaced per stroke, making a small correction for the "slip"; the correction generally being arrived at by guesswork.



Sheet A No. 1

Station No. 25 Date 9-18-23

Nominal dia. 16" Calipered dia. 16" Area, A ____ sq. ft.

Indicate in circle all taps, and position of Pitot Rod for this traverse

looking up stream

Specific Gravity of liquid, S = 1.585

$V = 1.667\sqrt{Hd}$. $V = 1.275\sqrt{Hd}$

$G = FV_c$, where F = station factor = 646,309 AC

Trav. coef. by this traverse, $C = \frac{60.59}{71.45} = .847$

Average of all traverses, C = ____ F = ____

Time of traverse, from ____ M. to ____ M.

By whom ____

Also see Sheet B No. 1 ____ and Sheets A No. ____

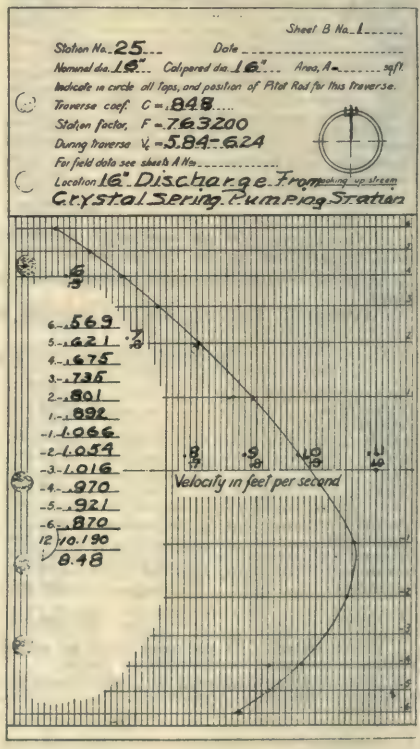
Location 16" Discharge From Crystal Spring Pumping Station

n	d	d_c	V	V_c	Values of V when V_c = 1.00
6	6 1/2	21	3.25	5.84	.556
5	8	21 3/4	3.80	5.94	.606
4	9	21 3/4	3.82	5.94	.643
3	11	21 1/2	4.23	5.90	.717
2	14 1/4	22	4.80	5.97	.805
1	17 1/2	24	5.32	6.24	.853
-1	26 1/2		6.56	6.10	1.075
-2	25 1/2	22	6.43	5.97	1.077
-3	23 1/4		6.14	5.93	1.035
-4	20 1/2	21 1/2	5.76	5.90	.977
-5	18 3/4		5.51	5.87	.939
-6	16 1/2	21 1/4	5.17	5.85	
			60.59	71.45	
			AVERAGE		.847

13

And yet there is available at small cost, and which can be easily operated, a simple method by which the slippage can be accurately determined.

Recently the writer had occasion to determine the actual slippage of one of the main pumps of the Roanoke Water Works Co. of Roanoke, Va. The instruments used were the Pitot tube, manometer and counter of the engine. A tap was made on the top side of the 16-in. discharge main, a short distance from the pump, for a 1-in. corporation cock, and the rod screwed on to the plug, the impact orifice facing the discharge of the pump. The manometer, or U-tube as it is sometimes known, was attached to the rod, thus making a simple instrument to measure the flow of water. It was set up and read without disturbing the operation of the pump and did not hinder the flow, as far as is known.



To determine accurately the amount of water that was flowing through the pipe, it was first necessary to determine the relation between the mean velocity and the center velocity; and once having found this coefficient it was a simple matter to figure the flow. As the Pitot tube measures the velocity only at the point where the orifices are placed, it is necessary to move the orifices along the diameter of the pipe. The velocities at the different points vary, the maximum

occurring at, or near the center of the pipe. The pipe was divided into six imaginary rings of equal areas, the distance to the center of each area computed from the formula $Rn = \sqrt{\frac{2n-1}{2N}}$ where n is the nth area, counting the center area as zero, N the number of areas, R the inside radius of the pipe and Rn the radius of the nth area.

For a 16 in. pipe and six rings or areas, R1 was found to be 2.30 in.; R2, 4.00 in.; R3, 5.17 in.; R4, 6.12 in.; R5, 6.93 in.; R6, 7.65 in.; all of the distances being from the center of the pipe. The manometer was half filled with carbon tetrachloride (specific gravity 1.58) and colored with red dye. As the rod was placed at the different points the deflections of the liquid in the tube were read. Following the reading at each point the rod was returned to zero (center of the pipe) in order to catch any change in the center velocity. The velocity of each point was computed from the formula $V = c\sqrt{2gH}$, c being the coefficient of the tube (.72 for this particular type of rod), and H being the specific gravity of the liquid used in the tube minus one. The coefficient was determined by divding the average of all the velocities (V) by the average of the center velocity, as shown on sheet "A" No. 1. The gallons per 24 hours, taking the center velocity as unity, was calculated to be 763,200. The test was conducted over a period of 20 minutes. The manometer deflection was read every minute and the counter was read at the beginning and at the finish of the test. A comparison of the rate of flow obtained by the two methods showed a slippage of 3.56 per cent. This checked closely with the slip that had been allowed when computing the pumpage. The theoretical displacement of the pump is 85.7 gal. per revolution, or a slippage of 3.15 per cent. The engine was running a little under 37 r. p. m. at the time of this test. The pump was installed in 1906 by the Snow Pump Co., and is of the horizontal cross-compound type. It has a capacity of 5,000,000 g. p. d. against a head of 237 ft., and its rated speed is 40 r. p. m.

The test was made in connection with the study of the system under the direction of C. C. Behney of the Simplex Valve & Meter Co.

The following is tabulation of observations taken and results obtained. The traverse coefficient of main here was established as .846, which gives 763.200 for the station factor:

Time	S=1.58 d	Vc	Rev. Counter Readings	Revolutions	Gallons Per Day Pump	Pitot Tube	Slip
4:05 P. M.			817277				
4:07 P. M.	22	5:97					
4:08 P. M.	22	5:97					
4:09 P. M.	21	5:84					
4:10 P. M.	21.25	5:87					
4:11 P. M.	21.5	5:90					
4:12 P. M.	22	5:97					
4:13 P. M.	22	5:97					
4:14 P. M.	22	5:97					
4:15 P. M.	21.5	5:90					
4:16 P. M.	21	5:84					
4:17 P. M.	21	5:84					
4:18 P. M.	21	5:84					
4:19 P. M.	20.75	5:80					
4:20 P. M.	21	5:84					
4:21 P. M.	20.5	5:77					
4:22 P. M.	20	5:70					
4:23 P. M.	20	5:70					
4:24 P. M.							
4:25 P. M.			818020				
Summation		99:69		752			
Averages		5.864			4,640,000	4,475,000	3.56

Three Years' Work of Federal Power Commission.—Applications involving an estimated installation of 21,500,000 h. p., permits and licenses issued for an aggregate installation of 7,500,000 h. p., and 2,400,000 h. p. built or building under license of the commission, is the record of three years' administration of the federal water power act. In this period the commission has dealt with applications involving six times as much horsepower, has issued permits and licenses involving three times as much horsepower and has twice as much horsepower built or building as the individual departments working independently in the preceding 20 years.

Hydraulic Chronology

Table of Some of the Important Developments in Connection With th Science of Hydraulics

By LOUIS MITCHELL DEAN,
College of Applied Science, Syracuse University

The student of any science is usually interested in its history. It gives him an appreciation of the long time, and of the slow, painstaking work that has been necessary to bring us to the present stages of our knowledge.

It may stimulate and encourage him to have a share in the future progress of the science.

In order to present the historical background in a brief and yet somewhat comprehensive manner, the writer uses in his course in hydraulics a table of some of the important developments pertaining directly or indirectly to this science.

It is recognized that this table is not complete, but it is believed to be fairly representative. This method of presentation seems to appeal to students who are studying hydraulics for the first time and it may be of some interest to all engineers, particularly those whose work is along hydraulic lines.

2250 B. C.—Code of Hammurabi. Contains provisions for handling water used in irrigation.

1000 B. C.—Bamboo float wheels said to have been used by the Chinese.

590 B. C.—Nebuchadnezzar contructed reservoirs and canals near Babylon.

312 B. C.—First Roman aqueduct was built.

250 B. C.—Archimedes, Greek scientist of ancient Syracuse, invented the screw pump; discovered the law governing floating bodies.

1581—Float wheel installed at London Bridge to operate pumps for water supply of the city.

1582—First pump erected on old London Bridge for supplying the city through lead pipes.

1586—The Almanza dam, in southern Spain, was in use prior to this date. Used for irrigation purposes.

1612—Galileo (Italian astronomer), published a treatise discussing the hydrostatic paradox and the law of floating bodies.

1628—Castelli, pupil of Galileo, firs uses velocity as an element in esti mating discharge.

1629-95—Huygens (Dutch mathema tician), first found the numerica value of "g," acceleration due t gravity.

1643—Torricelli, Italian physicist pupil of Galileo, discovered the lav governing velocity of flow from a orifice. He also invented th barometer.

1652—First water works in Americ constructed at Boston; gravity sup ply.

1703—Dennis Papin, French engineer invented centrifugal pump.

1718—Marcus Paulini discovered tha discharge through orifice could b increased by adding a short tube.

1732—Pitot, French hydraulic engi neer, invented a device for meas uring velocity in streams, nov known as "Pitot tube."

1738—Daniel Bernoulli, Swiss mathe matician, proposed law of flow i pipes.

1740—Barker's mill, simplest type o tangential wheel invented by a Dr Barker.

1742—John Bernoulli (son of Danie Bernoulli), worked with his fathe on hydraulic studies.

1753—Brahms discovered that veloci ty does not accelerate in accordanc with the law of gravity but tends t remain constant.

1764—Professor Michellotti carried o experimental hydraulic investiga tions. This is about the perio when studies begin to change fron theoretical to practical.

1775—Chezy, French mathematician gave the formula for flow in pipe and channels which bear his name

1790—Wolfmann, German hydraulic engineer, invents apparatus fo measuring velocity of flowing water Forerunner of modern curren meter.

1796—Joseph Bramah, English in ventor, built first successful hy draulic press.

1797—Giovanni Battista Venturi, Italian mathematician, published his research work on the flow of water and announced that fluids under pressure gain speed and lose head in passing through converging pipes and vice versa for diverging pipes. This is now known as "Venturi's Law."

1800—Steam engine first used in America for pumping. Philadelphia.

1804—U. S. patent issued to Benjamin Tyler, signed by Thomas Jefferson, for an improvement in water wheels. This is about the first turbine development in the United States.

1815—Drains in London first used to carry away sewage.

1817—Cast iron pipe begins to be generally used for water mains. were made of bored logs.
Prior to about this date water mains

1823—M. Fourneyron, French engineer, began experiments on type of reaction turbine.

1826—Poncelot, French engineer, proposes a type of inward flow turbine.

1826—Fourneyon, French engineer, proposes a type of inward flow turbine.

1827—Poncelet and Lesbros perform their turbine experiments at Metz.

1827—The first Fourneyon turbine was erected at Pont sur l'Ognon, France.

1829—First modern slow sand filter, built by James Simpson for East Chelsea Water Co. at London.

1835—M. Castel, French engineer, performs experiments at Toulouse.

1840—High bridge built across Harlem River to carry water to New York City.

1842—Croton River water first used in New York City.

1847—Anglo-Saxon irrigation in United States begins. Mormon settlers start irrigation in Salt Lake City Valley, Utah.

1849—James B. Francis (American engineer), designed an increase flow wheel, regarded as origin of American type of turbine.

1850—Principal water works development in United States took place after this date. 83 water works then in existence.

1851—James B. Francis, American engineer, experiments with rectangular weirs, proposes formula.

1855—E. S. Chesbrough, American engineer, designs first comprehensive sewer system in United States (for Chicago).

1857—Henri Darcy, French engineer, publishes results of his experiments on flow of water in pipes. First to make thorough investigation of friction loss in pipes.

1865—H. Bazin, French hydraulician, publishes results of his experiments on flow in channels.

1865—"Hurdy Gurdy"—or flat vaned water wheel, forerunner of Pelton Water Wheel, introduced in mining district of California.

1866—James P. Kirkwood (American engineer), reports on filtration of river water. This marks the beginning of filtration of water supplies in the U. S.

1869—Kutter and Ganguillet, Swiss engineers, investigated flow in open channels and published results. Proposed "Kutter's Formula."

1872—At Poughkeepsie, N. Y., was made the first practical attempt for municipal purification plant in U. S. for water supply. Plans made by James P. Kirkwood.

1877-79—Alphonse Fetley and Frederic P. Stearns, American engineers, investigate flow over weirs and propose formula.

1882—Present turbine testing flume of Holyoke Water Power Co. was completed.

1886—Henri Bazin being investigation of flow over weirs.

1886-88—John R. Freeman, American engineer, investigated flow through hose and from fire nozzles and published results.

1887—C. Cippoletti, Italian engineer, invents type of weir which bears his name.

1887—Clemens Herschel, American engineer, invents Venturi meter.

1888—U. S. Geological Survey begins to collect data in regard to water supply in the U. S.

1893—Slow sand filter built at Lawrence, Mass. First filter built in America for purpose of reducing death rate. Designed by Hiram F. Mills, American engineer.

1895—Construction began on Quaker bridge across Croton River, New York water supply. First high masonry dam in America (275 ft. high). Completed in 1907.

1897—H. Bazin proposes formula for flow in open channels—"Bazin's formula" based upon studies and experiments.

1897—Toukovsky, Russian engineer, proposed water hammer formula.

1902—Williams-Hazen formula for flow of water in pipes and other passages. Gardner S. Williams and Allen Hazen, American engineers.

1909—Imhoff tank treatment of sewage introduced in U. S. Method developed by Dr. Karl Imhoff, Germany.

1913-14—Dr. Gilbert Fowler, England, developed actuated sludge method of sewage disposal.

1913—Miami Conservancy District (Ohio) begins investigations in flood control works. A. E. Morgan (American engineer), chief engineer. Many reports of work and investigations published.

1915—Installation of comprehensive sewer system for Baltimore marks completion of sewer systems for all large cities.

Measuring Water With Salt and Electricity

Research Narrative of Engineering Foundation

Professor C. M. Allen, of Worcester Polytechnic Institute, has recently added a method which is giving results of remarkable precision. Like other methods of modern science for measuring quantities of many kinds, it is indirect. It depends upon the fact that common salt increases the electrical conductivity of water in proportion to the quantity of salt dissolved in the water. The salt velocity method consists in accurately timing between two known points the passage of a charge of brine which has been injected into the water at a point upstream. Dividing the volume of the conduit between the two points by the time of passage gives the rate of flow, or discharge.

For introducing the salt, a strong brine is injected under pressure at an upstream point through a system of small pipes so placed as to give approximately uniform distribution in the cross-section of the conduit. At one or more convenient places downstream, electrodes are inserted in the conduit and used to detect the changing conductivity of the water as the brine passes. The timing of the passing of the brine is done by means of a stop-watch or recording seconds clock and indicating or recording electrical instruments.

The instant of introducing the brine may be registered by a switch operated in conjunction with a quick-opening brine introduction valve, or by a pair of electrodes placed just below the brine distributing system. The times of passage by the downstream points or sections of the conduit are obtained by the use of one or more pairs of electrodes inserted in the conduit at each point.

The recording chart can be run at various predetermined speeds to suit the conditions of the test. All events can be registered mechanically or electrically on this chart, including time of introducing brine, passing of brine by one or more electrodes, and the elapsed time in seconds. From this chart the actual time of the passing the brine is obtained.

Comparative tests of the salt velocity method with the Venturi meter, the weir, and the weighing tank, show it to be very accurate. It requires no unusual equipment for controlling the flowing water, no huge tanks and scales, no long interruption of the operation of the power plant in which the water is being used.

This method may be compared to the submerged float method of measuring the quantity of water flowing through canals of uniform cross-section, by which the mean time of passage of all the floats between two known points gives the mean velocity of flow.

Experiments were recently made on an 8-ft. pipe line over 3 miles in length with four pairs of electrodes installed in the line. About 50 minutes were required for the charge to pass through this pipe. Time of passage was accurately recorded at each pair of electrodes, the last pair giving as distinct a curve as any of the others.

Although this method of measuring water has been used as yet only at power plants, it is equally applicable to pipes, flumes and conduits for water supply and irrigation, and even to the measurement of stream flow.

Meter Installations and Meter Rates in Ohio

Results of a Study by the State Department of Health of Ohio Given in a Bulletin of the Department

By E. I. ROBERTS,
Assistant Engineer, Ohio State Department of Health

A study of meter rates and meter installations was undertaken by the State Department of Health of Ohio as a result of a large demand for information on this subject by officials of Ohio cities and villages. This demand was brought about by the increased cost in the operation of water works.

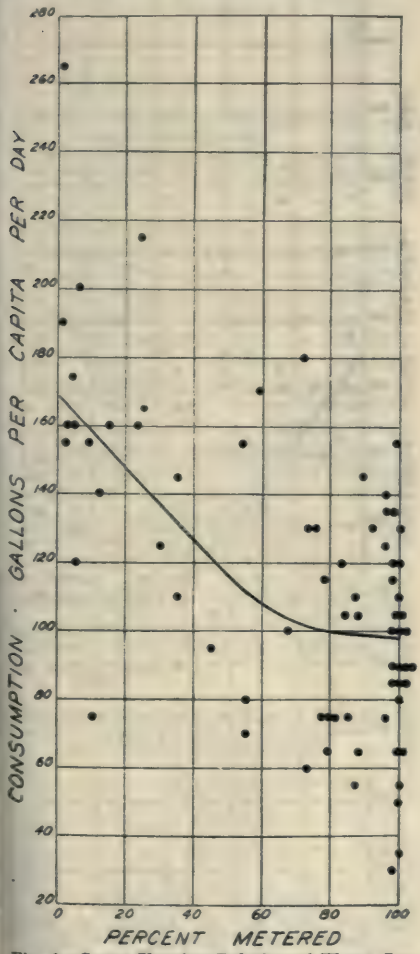


Fig. 1—Curve Showing Relation of Water Consumption to Metering for Cities in Ohio.

Effect of Meterage on Water Consumption.—The study indicates that for cities and villages of Ohio with services 100 per cent metered, the average daily consumption is 90 gal. per capita, and for cities and villages with no metered service, the average daily consumption is 170 gal. per capita. The average domestic rate in Ohio for surface water supplies filtered is slightly higher than the average domestic rate for well water supplies, while the average manufacturing rate for filtered water is slightly less than the average manufacturing rate for well water supplies.

One cannot conclude that the rates as they exist in Ohio indicate that filtered water is necessarily more expensive than well water, since the installation of water purification plants has generally been more recent than the installation of well water supplies. As a result rates for filtered water hav been increased in some instances to meet the cost of installation rather than the cost of producing water. We, therefore, cannot draw any definite conclusion from these rates but must simply state the rates as they are found to exist.

How the Data Were Obtained.—In making a study covering such a large number of cities and villages (150) as we have included in our list for study, it has been necessary to rely upon the co-operation of the officials connected with the various water works under consideration. For the most part, we have had the full and hearty co-operation of these officials.

Information for this study was obtained from three sources, viz.: information blanks sent out to each water works official; monthly reports on the operation of water purification plants, and records of investigations made by representatives of the State Health Department.

The largest amount of information was obtained from blanks sent out to water works officials.

The question of water consumption was omitted on the first blanks sent

out but was included on a second list which was sent to all cities and villages having well water supplies. Consumption for cities and villages with water purification plants was obtained from the monthly reports of operation received by the State Health Department.

It has been the practice of the division of sanitary engineering where possible, to secure information regarding water consumption and meter installations on each investigation that is made in the field. In this way we have secured some data which otherwise would not be available.

Division of Cities Into Classes.—For purposes of comparison, cities were divided into six classes, A, B, C, D, E and F.

Class A represents all cities with a population of 50,000 or more regardless of the type of supply.

Class B represents cities with populations from 15,000 to 50,000 and which purify water by filtration.

Class C represents cities with populations from 15,000 to 50,000 which secure their water supplies from wells.

Class D represents cities with populations from 5,000 to 15,000 which purify water by filtration.

Class E represents cities with populations from 5,000 to 15,000 which secure their water supplies from wells.

Class F represents cities with populations from 5,000 to 15,000 which obtain water from a surface supply which is not treated in a water purification plant.

Villages were divided into classes G and H:

Class G represents villages with populations from 2,000 to 5,000 which purify water by filtration.

Class H represents villages with populations from 2,000 to 5,000 which secure their public water supply from wells.

The eight classes include all of the cities in Ohio and all of the villages having public water supplies and populations from 2,000 to 5,000.

What the Study Shows.—The general effect of metering is graphically shown in Figs. 1 and 2, where consumption in gallons per capita per day is plotted against per cent of services metered. The graph shows that the average daily consumption for 100 per cent metered cities and villages in Ohio is 90 gal., and the average daily consumption for cities and villages without meters is 170 gal. Plotting a curve for cities alone, we find the average daily consumption for 100 per cent metered cities to be 100 gal. per capita and 170 gal. per capita for cities without meters. The lowering of the consumption curve when cities and villages are plotted together is probably due to the lack of sewerage systems in many of the villages.

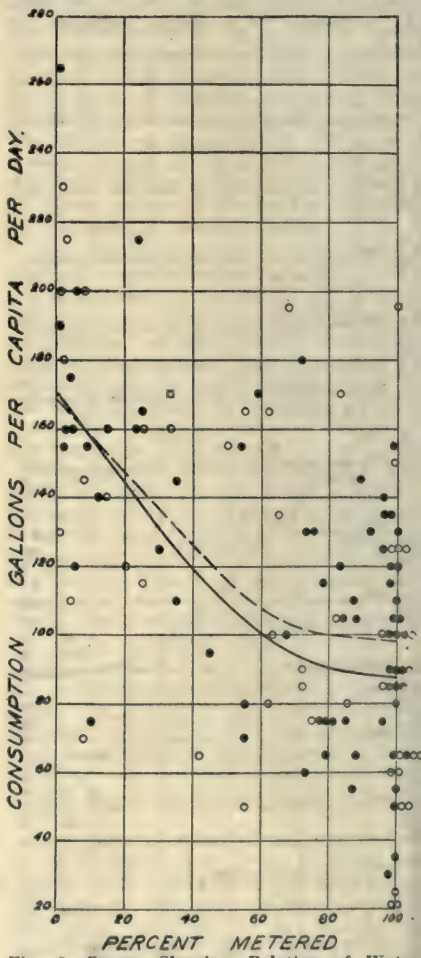


Fig. 2—Curves Showing Relation of Water Consumption to Metering for Cities and Villages in Ohio.

A summary of the average rates for the various classes of cities and villages, together with the average consumption and average per cent metered, is shown in Table I.

Table I—Average Consumption and Average Rates

Class	Average Consumption—(Gal. Per Capita Per Day)	Services Metered—(Per Cent)	Rates—Cents Per Thousand Gal. Domestic (Less Than 25,000 Gal. Per Month)	Intermed. (Between 25,000 and 250,000 Gal. Per Month)	Manufacturing (More Than 250,000 Gal. Per Month)	Min. Annual Rate
A	115	91	15	13	11	$8.07
B	120	68	32	19	13	9.15
C	105	78	22	16	14	7.18
D	130	63	37	21	13½	12.20
E	105	63	29	21	15	9.28
F	145	43	23	11	12	7.23
G	95	95	71 (48)	30	23	10.72
H	105	63	41½	28	25	8.88

Notes: The average consumption for each class is a weighted average according to populations of various municipalities.

The percentage of services metered is obtained by dividing the number of metered services by the total numbr of services for each class.

It will be noted from the table that the larger the city the lower the average cost of water per thousand gallons, and that the average cost of filtering water, as indicated by the rates for domestic use, is slightly higher than for well water supplies without filtration. However, the average cost of filtered water for manufacturing purposes is slightly lower than the cost of well water for manufacturing purposes. In the column marked domestic rate, Class G, it will be noted that the rate of 71 ct. is exceptionally high. This is due to the rate charged by one village alone, which, if omitted, would bring the domestic rate down to 48 ct. per 1,000 gal., making it comparable with water obtained from wells for villages in the same class.

Short Course for Texas Water Works Operators

The sixth annual short course of Water Works and Filter Plant Operators of Texas will be held in Waco, Tex., Jan. 21 to 26, the Texas Water Works Association, the State Board of Health, the Waco City Water Works, Waco City Health Department and Baylor University co-operating.

These courses of instruction were inaugurated by the Texas State Board of Health in 1919. The response has been so cordial that they have been continued, with each year showing a substantial increase in enrollment. The primary purpose of the school is to decrease water borne diseases in the smaller municipalities by training the operators in the approved methods of producing pure water. This is accomplished through lectures upon such subjects as coagulation and sedimentation, filter operation and chlorination. For instruction in chemical and bacteriological control actual work is done in the laboratory.

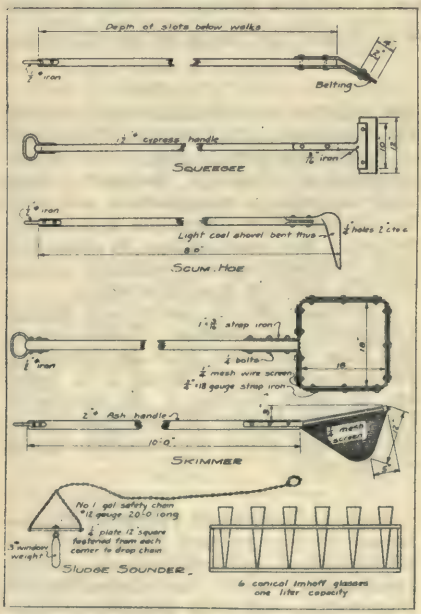
Professor W. T. Gooch of Baylor University is director of the school and the lecturers include Lewis I. Birdsall of Chicago, Major J. B. Hawley of Fort Worth, J. C. Nagle of Dallas, Professor E. P. Schoch of Austin and other well known water works men.

Sewage Treatment Plants in Minnesota.—At the present time there are 80 municipal and institutional sewage treatment plants in operation in Minnesota. Of this number 17 consist of septic tanks of the Cameron type, and 63 of tanks of the Imhoff type. Four municipalities are operating percolating filters and three municipalities are operating sand filters as secondary sewage treatment.

Increase of Water Service Connections in Minnesota.—Questionnaires recently sent out by the division of sanitation of the Minnesota State Board of Health indicate that during the years of 1920 and 1921 the total number of water service connections in the cities and villages of the state increased at the rate of about 4½ per cent per year.

Small Tools for Sewage Treatment Plants

The operation of sewage disposal plants requires the use of a number of special tools. In many instances these tools are developed by the operators or engineers, to meet their particular needs. On the opposite page we show several tools used in the operation of Imhoff plants. The illustration is taken from a bulletin, "The Operation and Care of Sewage Treatment Plants," by Stanley Pinel, published this fall by the Engineering Extension Department of Iowa State College. The hand skimmer is used for removing the floating material in plain sedi-



Small Tools for Use in Operation of Imhoff Plants.

mentation tanks or in the sedimentation chambers of the Imhoff plants. The illustration shows a sludge sounder devised for use with Imhoff plants. A "sounder" often used for measuring the quantity of sludge in the bottom of a septic tank consists of a board 12 in. square attached to a long wooden handle.

In Imhoff plant operation the walls and sloping bottoms should be cleaned with a squeegee every few days by slowly forcing the deposit through the slot. Extreme care should be taken that the sediment is not stirred up and carried to the outlet. The flow should be reversed in the tanks about twice a month to insure equal deposits in the sludge pits. The slots should be periodically cleared of caked sludge by flogging with a heavy chain attached to a long wooden handle. The scum in the gas vents should be broken up daily with a rake or water jet from a hose.

The Imhoff conical settling glasses shown in the illustration, are also used for testing the character of the sedimentation effluent of plain sedimentation tanks and septic tanks. The test is made as follows:

At the same hour each day fair samples should be taken of both the influent and effluent of the sedimentation chamber by filling conical Imhoff tubes of one liter capacity up to the liter mark. After two or three hours settling, the volume of the sediment in each sample can be read by means of the cubic centimeter graduations at the bottom of the tube. During the settling, the particles lodged on the side walls should be freed by carefully twisting the tube in the rack or by using a glass rod. The result of the tests should be accurately recorded in a log of the plant. Corrective steps should be taken if there is considerable sediment in the effluent tube.

The stability test for the filter effluents is a very important test, as it indicates the quality of operation of the entire plant. Each day two samples should be taken in 8-oz. glass-stoppered bottles, one of the effluent as it leaves the filter and one of the water in the watercourse just below the sewage outlet (say 100 ft.). One-half a cubic centimeter of a 1/10 per cent solution of methylene blue is added to each bottle and the stopper inserted with a twisting motion so as to make it tight without a bubble of air remaining in the bottle. The bottles are labeled as to contents and date taken, and are then kept at 70° F. for 14 days. Each day the samples are observed. When a sample has become decolorized, the number of days standing should be recorded and the sample discarded. Retention of the blue color for at least 10 days is considered necessary, and indicates that the effluent is sufficiently stable to run into a watercourse. The results of this test should be accurately recorded.

Methods for Control of Algae

Use of Copper Sulphate and Experiences at Fort Worth, Tex., Described in November Journal of American Water Works Association

By W. S. MAHLIE,
Chief Chemist, Water Filtration Plant, Fort Worth, Tex.

The United States government made a fairly complete survey about 20 years ago of algae commonly responsible for troubles in water and the data obtained at that time have served as a basis for algae control. The following is a list of the 12 kinds commonly found:

Organism	No. of Cases	Per Cent	Type
Anabaena	27	8.4	Blue
Asterionella	9	2.8	Diatom
Beggiatoa	20	6.2	Higher bacteria
Chara	26	8.1	Green
Cladophora	17	5.3	Green
Clathyrocystis	23	7.1	Blue
Conferva	56	17.3	Green
Crenothrix	13	4.0	Higher bacteria
Fragilaria	19	5.9	Diatom
Navicula	21	6.5	Diatom
Oscillatoria	49	15.2	Blue
Spirogyra	43	13.3	Green
Total	323		

Kellermann, in a report showing the geographical distribution of algae, showed that Chara, Conferva, Navicula, Oscillatori and Spirogyra are the ones usually reported as responsible for troubles in Texas.

Methods of Control.—In nearly all the references in the engineering literature we find that algae troubles are encountered with conditions which are not met usually in a rapid sand filter plant. In many cases where troubles have been encountered the water was pumped directly from the storage reservoirs to the consumers without filtration, but with only chlorine sterilization.

Again many cases are on record where there has been trouble in connection with slow sand filters. In other instances, after the water had been filtered it was stored in an open clear well. Now in our later type of rapid sand filter plant such conditions are usually not encountered.

Where the stream flow is sufficient, no preliminary reservoirs are built, but the water is taken directly from the river and then filtered. The modern plants all have the clear well covered to prevent contamination.

Where we have large preliminary reservoirs, or clear wells, we may treat the algae effectively by giving it the proper dose of copper sulphate.

In a rapid sand plant where we do not have large preliminary basins, and where there is a constant displacement of the water by the incoming water, we have an entirely different proposition. In such cases the walls are usually painted with copper sulphate about once each month, to keep the growth at a minimum, and the algae are usually all removed by filtration. An increased dose of coagulant is effective here. The method of filter handling is usually changed also.

When algae are present in unusually large amounts, the loss of head on the filters will build up quickly, and there will be much more wash water used than ordinarily. When water is "heavy with algae" it will have a sort of silky appearance. Fortunately when the growth of algae is heavy the bacterial content is low. This permits a little juggling of the filters to save wash water.

The following is the method used in such cases. This was used very successfully at Panama by F. H. Waring, now sanitary engineer, Ohio State Department of Health, and also by J. W. Ellms at Cincinnati O.

1. Give a regular or full wash to filters at about usual intervals for normal filter runs as if algae were not present.

2. For all full washes cut wash water time to three minutes.

3. Adopt a schedule of one or more intermediate or partial washes, using wash water time of one minute.

4. If conditions become acute with filter runs (partial washed) less than one hour, use scheme of disturbing surface clogging of filter as follows: leave sewer closed; shut effluent; turn on full wash water rather quickly and then close; put filter in service again by opening effluent.

This practice of "disturbing" filters may be used once or twice in be-

tween partial washings of the filter. If air is available in washing, substitute the air for wash water in the above procedure for disturbing. Throughout the period of algae trouble use chlorine in generous amounts.

Applying Copper Sulphate to Reservoirs.—The usual method of applying copper sulphate to reservoirs is to weigh the proper amounts into a gunny sack, tie it to a boat and drag it through the water slowly, in such manner as to give equal distribution. Another method which has been used successfully at New York is to feed the chemical into the raw water conduit by means of a dry feed chemical machine. This method is especially valuable in times when the reservoirs are frozen over. It is also advantageous because the flow of water through the conduit may be determined accurately and allows a better control over the dosing than if the water is in an irregular shaped reservoir, whose contents are naturally more difficult of measurement.

Amount of Copper Sulphate Necessary.—The amount of copper sulphate required has been carefully worked out by experiment and by actual experience. After the organism responsible for the trouble has been identified, it is only necessary to refer to a table and see what dose is required. The amount of copper sulphate is also influenced by such factors as temperature, organic matter, alkalinity and turbidity. It was recommended by the United States government to add 2.5 per cent for each degree temperature below 15° C; subtract 2.5 pr cent for each degree temperature above 15° C; add 2 per cent for each 10 parts per million organic matter; and add 0.5 to 5 per cent for each 10 parts per million alkalinity. If the carbonic acid is low, add 5 per cent. In general the blue algae take a smaller dose than the green. The amounts of copper sulphate range from 0.07 to 10 p.p.m. Usually 1 p.p.m. is sufficient.

Copper Sulphate Required for Diatoms

	Parts Per Million	Lb. Per Million Gal.
Asterionella	0.20	1.7
Fragilaria	0.25	2.1
Melosira	0.33	2.8
Navicula	0.07	0.6
Synedra	0.50	4.2
Tabellaria	0.50	4.2

Copper Sulphate Required for Blue Algae

	Parts Per Million	Lb. Per Million Gal.
Anabaena	0.12	1.0
Ahpanizomenon	0.50	4.2
Clathyrocystis	0.12	1.0
Coelasphaerium	0.33	2.8
Microcystis	0.20	1.7
Oscillaria	0.50	4.2

Copper Sulphate Required for the Schizomycetes or Higher Bacteria

	Parts Per Million	Lb. Per Million Gal.
Beggiatoa	5.00	41.5
Cladothrix	0.20	1.7
Crenothrix	0.33	2.8
Leptothrix	0.40	3.3

Copper Sulphate Required for Green Algae

	Parts Per Million	Lb. Per Million Gal.
Cladophora	0.50	4.2
Closterium	0.17	1.4
Coelastrum	0.33	2.8
Conferva	0.25	2.1
Desmidium	2.00	16.6
Draparnaldia	0.33	2.8
Eudorina	10.00	83.0
Hydrodictyon	0.10	0.8
Microspira	0.40	3.3
Palmella	2.00	16.6
Pandorina	10.00	83.0
Raphidium	1.00	8.3
Scenedesmus	1.00	8.3
Spirogyra	0.12	1.0
Staurastrum	1.50	12.5
Ulothrix	0.20	1.7
Volvox	0.25	2.1
Zygnema	0.50	4.2

Copper Sulphate Required for Protozoa

	Parts Per Million	Lb. Per Million Gal.
Chlamydomonas	0.50	4.2
Crytomonas	0.50	4.2
Dinobryon	0.33	2.8
Euglena	0.50	4.2
Glenodinium	0.50	4.2
Mallomonas	0.50	4.2
Peridinium	2.00	16.6
Synura	0.20	1.7
Uroglena	0.10	0.8

The Effect of Copper Sulphate Upon Algae.—It is not definitely known just what happens to the algae when copper sulphate is used. In all probability the copper attacks the outer cell wall in the same manner that it attacks cellulose, and liberates the cell contents. Microscopic examination after the algae have been treated apears to confirm this, for the cell contents appear to have been scattered and changed in color.

All of the copper sulphate applied is not used up or consumed by the organisms, but a part of the copper is precipitated out by the bicarbonates of calcium present in the water. For this reason, it is seldom that any copper ever gets into the water in such condition as to be consumed by

the people. We have used some rather heavy doses of copper sulphate at Fort Worth and in no case could we ever find any traces of copper in the water after filtration.

Invariably, after copper sulphate has been applied, there is an increase in taste and odor for a few days, due to the decomposing organisms. This is nearly always accompanied by an increase in the bacterial content. Since many of the organisms killed by the copper feed on the bacteria, it is only natural that when these are killed that there will be an increase in the numbers of bacteria.

Objections to the Use of Copper Sulphate.—It has been pointed out that copper compounds are poisonous and for this reason there is much objection by certain people to the use of copper. Their objections are usually the result of prejudice and ignorance. In many cases copper compounds are used in medicine in doses ranging from 3 to 15 grains, and some cases are on record of doses as high as 60 grains. The United States government says in Bulletin 76, Bureau of Plant Industry, "There is no authentic record for fatal copper poisoning and many of the best authorities do not consider copper a true poison; they hold that it is a natural constituent of the body, and in minute quantities has no effect upon man." On the other hand, there is much evidence to show that copper is very beneficial in the treatment of typhoid fever and cholera. In the amount of copper compounds used in water for the destruction of algae there certainly is no cause for alarm.

The argument advanced by a great many objectors to the use of copper is that, when copper is applied to water, a number of fish are usually killed. This is caused by the fact that when the copped sulphate is applied at certain points the water will contain a great deal of the copper which is afterwards mixed and scattered, or diffused throughout the entire body of water. If a fish gets a dose of this heavily laden water he naturally gets into difficulty. But this condition is not charactertistic of the entire body of water, and disappears quickly. Many people will insist that if copper will destroy fish it will affect man. When one stops to consider the vast difference between fish and man, the objection will lose a great deal of its force. The following table shows the amount of copper sulphate generally considered necessary for the destruction of fish:

Killing Dosage of Copper Sulphate

	Parts Per Million	Lb. Per Million Gal.
Trout	0.14	1.2
Carp	0.33	2.8
Suckers	0.33	2.8
Catfish	0.40	3.5
Pickerel	0.40	3.5
Goldfish	0.50	4.2
Perch	0.67	5.5
Sunfish	1.33	11.1
Black Bass	2.00	16.6

Use of Chlorine for Destroying Organisms.—In late years the use of chlorine has been demonstrated with success in the destruction of certain forms of organisms. Chlorine is especially valuable for the treatment of animal organisms. The dose required is usually much greater than that used for the destruction of bacteria, and consequently there would be a taste imparted to the water. The excess of chlorine, however, is easily neutralized by some reducing agent, as sulphur dioxide. This treatment eliminates the objections from the use of copper sulphate. The city of New York has used chlorine for this purpose with much success.

A compound of chlorine and ammonia, known as chloramine, has also been used successfully by Montfort in the eradication of the troublesome Crenothrix.

Experiences With Algae at Fort Worth.—In August, 1921, our aeration basin was much troubled with growths of algae. There apparently was no increase in the taste and odor from these organisms, but they were very unsightly. In some instances they were stretched out as long as 10 ft. These greenish-brown messes did not look inviting to visitors at the plant. These growths adhere tightly to the sides of the basin and to the aeration nozzles.

At this time we cut the basin out of service and removed the algae by pulling and scraping them away. This was rather a nasty job. After the surfaces were freed as much as possible from these growths we painted the entire inside of the basin with a thick solution of lime. We let this harden a day by air drying before we put the basin back into service again.

For about three weeks no appreciable growth was noticed, but in the next two weeks a heavy growth took place. Upon cleaning the next time, about six weeks after the painting, we had no difficulty whatever in washing off the algae with a stream from the fire hose, whereas formerly it had been nearly impossible.

A little later in the year we painted the walls of our sedimentation basins. Previously to this cleaning we had short growths of algae on the walls extending down about 3 or 4 ft. from the water line. After painting the walls with lime solution and upon cleaning the next time, about six months later, we found growths extending down nearly 10 ft.

The smooth surface formed by the lime painting prevented the algae from adhering so tenaciously and made it easier to dislodge them with the fire hose. As sunlight is one of the requirements for growth, and when we painted the walls with the white lime we allowed sunlight to penetrate somewhat deeper than previously, the reason for the deeper growth is obvious.

We have observed that the sunlight appears to be of some importance in the color that the algae will take. On the north side of our plant, the algae are of a darker green color than those growing on the south side, while the microscope shows them to be identical in form.

We have noticed also that in some parts of our plant, where the water has a greater velocity than at other parts, invariably the algae do not grow down as deeply on the side walls as at the places where the water has a lower velocity. The rapidly moving water apparently dissipates the light.

These sunlight effects suggest interesting experiments, to determine what effect the different colors would have upon the growth of algae. If we painted the walls white we would have increased the growth of algae and increased destruction of bacteria. If we painted the walls black we undoubtedly would get less algae and more bacteria; conditions favorable for the growth of algae are unfavorable for the growth of bacteria and vice versa.

Lime Treated Water and Algae.—A rather interesting experience was observed here at Fort Worth during the latter part of April and the early part of May, 1922, while we were having our floods. At this time our entire plant was flooded, and when we started operations again, for various reasons, we wanted a water containing a slight excess of lime or caustic alkalinity. After treating the water properly for this condition for a short time, we observed that wherever the water reached the algae they were killed. Inasmuch as another of the requirements for algal growth is carbon dioxide, it was obvious that in the absence of this plant food the algae simply died of "starvation."

Cast Iron Pipe Production in October

The U. S. Department of Commerce announces statistics on the production, shipments, orders and stock of cast iron pipe for the month of October, 1923. The report includes returns from 12 establishments and is confined to bell and spigot pressure pipe exclusively.

Table I gives the total tonnage for each of the principal items of the industry; Table II shows, comparatively, the principal items by months. The figures for September are revised in accordance with corrections received since the preliminary bulletin for that month was issued.

Table I

	Tons
Cast iron pipe produced during the month	88,696
Cast iron pipe shipped during the month	88,000
Orders for cast iron pipe specified to be shipped from stock	17,431
Orders for cast iron pipe specified to be made	119,947
Orders for cast iron pipe not specified as to sizes	443

Table II—Comparative Summary by Months, 1923

Months	Production (Tons)	Shipments (Tons)	Orders: To Ship From Stock (Tons)	Orders: Specified to Make (Tons)	Orders: Sizes Not Specified (Tons)
June	81,208	88,318	17,905	199,271	4,366
July	79,528	77,828	16,839	183,130	4,215
August	84,588	84,843	14,727	165,518	6,860
September	76,945	77,226	14,401	155,586	1,802
October	88,696	88,000	17,431	119,947	443

Extension of Deer Island Outlet Sewer

Methods Employed by Metropolitan Sewerage Works, Boston, Mass., in Extending Outfall Described in October Journal of Boston Society of Civil Engineers

By RALPH W. LOUD,
Assistant Engineer, Metropolitan District Commission

The extension of the outfall at Deer Island from its original location about 200 ft. west of Deer Island, where the sewage had been discharged continuously from the first operation of the north metropolitan system in 1895, to a point in deep water 322 ft. farther south by means of 84-in. diameter cast iron pipes and special castings was begun in 1915.

The original outfall was on the southerly slope of Deer Island Bar, about 1,900 ft. from the Deer Island mainland and about 3,500 ft. from the Deer Island pumping station, where the sewage was lifted to elevations sufficient to discharge it continuously against the varying tidal head. The outlet was ½ ft. below mean low water and discharged vertically upward. The general direction of flow was toward the main ship channel, where strong currents tended to dissipate the sewage rapidly.

Typical Outlet Pipe for Deer Island Outfall Extension

This outfall was placed at a time when such method of sewage disposal was practically untried, on a large scale, but had proven successful in so far as pollution of the shores was concerned. There had always been discoloration of the water in the ship channel for some distance, perhaps ½ mile, about the outfall. The outfalls of the South Metropolitan System, placed about 9 years after that at Deer Island, are 30 ft. below low water. The condition of the harbor water had been so much better around these outfalls that the Metropolitan Water and Sewerage Board sought to improve the North Metropolitan System outfall by a similar submergence, with the added improvement of multiple outlets.

Complaints about the condition of the water surrounding the Deer Island outfall had been made by boating interests, also by officials of the United States government, in view of the proposed use of the south end of Deer Island for military purposes, and because of the proximity of the Deer Island lighthouse, a structure not in existence when the original outfall was designed.

The Temporary Outlet.—For the first step a temporary outlet had to be provided so that the sewage flow might be diverted during the construction of the extension of the permanent outfall. This temporary line was started at a point on the existing outfall sewer about 200 ft. back from the high-water line on Deer Island. Here a double-chambered stop-plank manhole was built, the chambers extending to the bottom of the old sewer, and a new branch was cut into it at an angle of 30 degrees.

From this manhole a 6 ft. 6 in. circular sewer of reinforced concrete was built, following in a general way the southerly shore line of the island for a distance of about 770 ft. From a second manhole, located where this 6 ft. 6 in. sewer ends, 400 ft. of 60 in. cast iron pipe was laid partly in open, hand-excavated trench and partly in dredged trench. A 90-degree bend forms the outlet of this line, the opening being upward and some 3 ft. below mean low water. This line was studied and designed with the expectation that it would at some time be extended to a point where the water is 45 ft. deep. With this provision of two outlets, the advantage of dis-

tributing the sewage over a considerably larger area will be gained.

Trenching for the Extension.—Dredging was commenced July 9, 1916, in preparation for the extension of the old line. As no dipper dredge which could work to the required depth was aavilable, the work was accomplished with orange-peel and clam-shell buckets. The material removed was almost entirely coarse gravel, although a little blue clay was encountered near the lowest depth reached. Dredging was continued along the center line of the trench, no particular attention being given to the side slopes until sufficient depth was obtained.

An area 64 ft. by 20 ft. was dredged to about 58 ft. below low water, the outer end of this area being about 322 ft. south of the old outfall. From this area the trench extended back to the existing outlet, the depth being such that re-establishment of the original surface conditions after the pipe was in place would leave the pipe slightly covered to a point on the pipe a little north of the first outlet opening. From this point to the outer end, the grade of the pipe brings it gradually above the sloping ground. The water-line of the pipe at the extreme end is about 54 ft. below water.

Foundation for Pipe.—In the sloping trench for a distance of 54 ft. northerly from the level area described, single stones 6 ft. to 7½ ft. long by 4½ ft. wide by 2 ft. thick were laid firmly on the gravel bed of the trench as a foundation for each pipe. Two concrete sills 8 in. by 12 in. by 6 ft. were set upon each of these stones to adjust the pipe to required grade.

From this point to the old outfall, pile bents of two piles each were used. The piles were driven 3 ft. each side of center line of the pipe. The bents were 4 ft. 6 in. apart and were capped with 10 in. by 10 in. yellow pine timber. The change to pile foundation was due to the fact that the dredged trench became hardly more than a level bench on the side of the slope. It was considered that the piles would afford a more secure support against lateral sliding.

Method of Laying Outlet Pipe on a Slope.

Over the level area at the south end mentioned above a layer of granite chips was placed between stations 2+58 and 3+22 to even up irregularities left in dredging. On this bed granite blocks 2 ft. in thickness were placed. Most of these blocks are from 12 to 15 ft. long by 4 ft. 6 in. to 5 ft. wide. Some few are more nearly square, measuring about 9 by 7 ft. by 2 ft. thick.

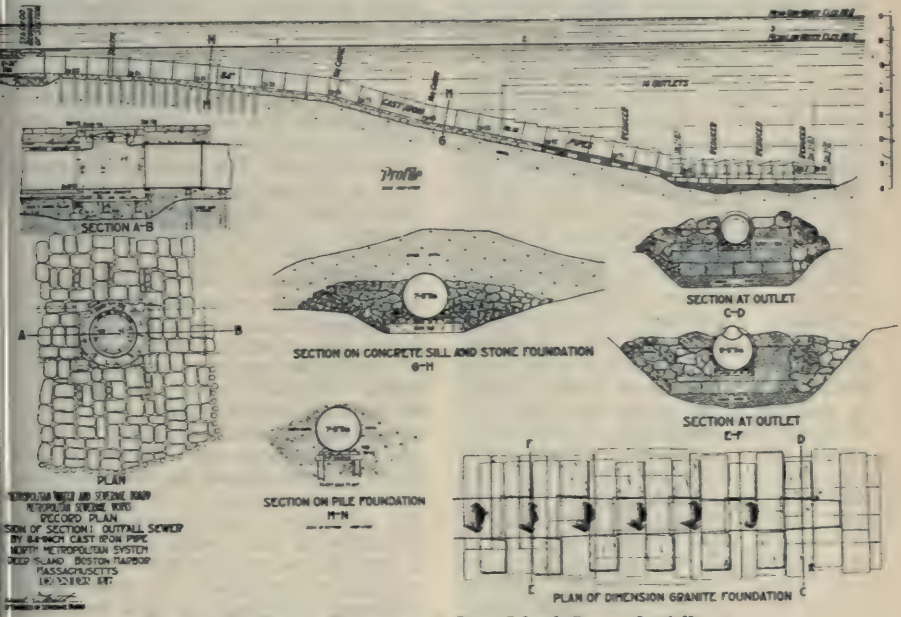
On this foundation course a second course of dimension granite blocks 2 ft. thick was placed. The stones in this course are so laid that the outer ends of adjacent stones are near opposite side of the lower course and the inner ends overlap under the pipe, forming a continuous layer. In this way spaces were left on either side of the pipe between alternate stones into which buttress stones 6 ft. by 5 ft. 6 in. by 4 ft. were fitted. These buttress stones, placed against the pipe just back of the bells, secure the pipe against any lateral or longi-

tudinal movement. The three outer buttress stones, on the east side of the pipe location, were set before the pipe was placed.

The Pipe and Specials.—The 84 in. pipe, with specials, were furnished under contract and were brought to South Boston by rail, lightered to the Deer Island shore and landed on the beach at high water. The pipes, which are in 9 ft. lengths, are 2 in. thick and have bells 6 in. deep. The standard pipes weigh about 17,000 lb. each. The heaviest piece, a reducing tee 75 in. by 84 in. by 75 in. and 11 ft. long, which made the connec-

Laying the Pipe.—In placing the sections, the lighter was secured to permanently established mooring lines and drawn into position above the prepared foundation. The pipe was then lowered on to the concrete sills placed by the divers, adjusted to required grade and securely blocked. The outermost two sections were placed in this manner on the heavy stone foundation and the remaining buttress stones were set in position.

The third section, consisting of two straight pipes and a curve, extends beyond the heavy stone foundation described and is laid with consider-



Typical Details for Extension of Deer Island Sewer Outfall.

tion with the original structure, weighs 24,980 lb. Twenty-three of these pipes, including all those having outlet openings, were coated externally with "Bitumastic" enamel while on the Deer Island shore. The object of this treatment was to protect the more directly exposed pipe from the action of salt water. To lay the pipes, six at a time were taken aboard the lighter of the contractor and made together on blocking into 3-pipe sections, the joints being leaded. These sections were handled by being slung from a strongback in straps of wire rope by the derrick boom of the lighter.

able slope, about 1 to 4½. It was obvious that, to lay the pipe on this slope without danger of displacing the sills, the pipe must be lowered in a sloping position so that the spigot end could be inserted in the bell of the previously laid pipe before the other end came to a bearing. To accomplish this, the contractor provided a special strongback formed of two 15 in. steel channels riveted together with separators between. Three hanger plates were riveted to the sides of each channel, and to these hangers were attached straps of wire rope. In slinging the pipe, the free end of these straps was hooked into

the eye of a turnbuckle suspended from the hanger at the other side of the strongback. This afforded a very convenient method of tightening the straps.

Near either end of the strongback was a pin 3 in. in diameter around which was passed an endless, heavy wire cable. The two strands of this cable passed through a yoke, the position of which could be adjusted before the apparatus was brought under tension. Under tension, the yoke was clamped rigidly in position. By trial, the position of this yoke was so established as to give the required slope to the pipe and the suspended section was then lowered to place.

Calking the Joints.—The joints between the sections were calked by the divers with led wool with ordinary calking tools. A strip of lead cast 6 in. wide by ½ in. thick and of sufficient length to extend around about one-third the perimeter of the pipe was placed in the lower part of the bell of each slip joint. This served to keep the spigot end up in alignment and to reduce the amount of calking required at the most difficult part to reach. In addition to the lead so placed, each joint required about 150 lb. of lead wool and consumed about two days' time for completing the calking. One diver would usually be calking joints while the other was at work preparing the foundation to receive another section. During the period of strongest tidal current, when material could not be lowered, both divers worked on the joints.

Owing to the exposed location of this work, there was necessarily much lost time. The unusually stormy spring and summer with much foggy weather was especially unfavorable, and work other than dredging was not started until about Sept. 20, 1916. The swift currents and frequent heavy undertow encountered in this location rendered the placing of material other than rough stone for riprap work impossible except at slack water on days when there was no considerable undertow.

Suspension of Work for Winter.—When it became necessary to suspend work on account of winter weather conditions, four sections of pipe (108 ft.) had been placed. Two of these sections were laid on the heavy stone foundation with but little slope and the other two were laid on the incline. Blocks of broken granite and granite chips had been placed under and around these pipes and between the buttress stones, forming a defense extending about 20 ft. on either side of the center line and rising to the general grade of the top of pipe. No backfilling was done about that portion of the line where the 14 outlets are located with any fine material which might be washed from place. The inshore end of the pipe and the three outlet openings in the section last laid were bulkheaded to prevent filling with gravel during the winter.

Work was resumed in the summer of 1917, the pipe laying was continued toward the existing outlet on a pile bent foundation to the point where the sleeve is shown. The existing outfall was broken out and the reducer "tee" 75 in. by 84 in. by 75 in. was connected into the existing channel. The branch was capped and the pipe extended to meet the pipe laid from the outer end. The closure was made with a sleeve, two pipes having both ends spigots being utilized for this purpose. The construction was completed on Dec. 3, 1917.

The Discharge End.—The discharge under the new conditions is from 14 outlet openings, increasing in size toward the outer end. The diameters of these openings, which are approximately elliptical with the exception of the outermost, which is a 48 in. circle, vary from 25 by 44 in. to 13 by 23 in., respectively. The reduction from 84 in. to the 48 in. terminal outlet is accomplished in 72 ft. by making alternate pipe into reducers, the reduction in each being 9 in.

The design of the pipe was determined as the result of studies for different conditions of tidal head and flow. The areas of the several openings are proportioned so as to discharge as nearly equal quantities as possible.

Examination of Outfalls.—An examination by diver was made of the outfalls in 1922. Those on the south line were found to be clear of deposit and in excellent condition. The outfall near the Deer Island light was in good condition, but there was considerable deposit in the outer portion of the discharge pipes. One of the discharge openings was found to be entirely choked with grease. The obstacles were all removed. Apparently this type of outfall is going to need more attention than those originally designed.

American Irrigation During the Past 23 Years

Important Advances Since 1900 Reviewed in Report of Committee on Irrigation, Dr. Samuel Fortier, Chairman, Presented Nov. 9 at 17th Annual Meeting of American Society of Agricultural Engineers

In spite of the natural conservatism of the farming class as such, the past 23 years have brought marked improvement in irrigation practice in western America, especially in those sections that have felt the pinch of water shortage due to rapidly increasing development. These improvements have also been especially noticeable where the higher priced products are being grown, and where irrigated areas have been subdivided into the smaller holdings desired in semi-suburban settlement.

Increased Duty of Water.—An increase in the duty of water in irrigation is one of the most obvious changes for the better in the past 20 years; yet because exactly duplicate measurements have not been made at the two ends of this period, specific comparative figures can not be cited in proof. But reading through government irrigation reports published about 1900 we find a gross duty under entire canal systems of 5 acre feet per acre per annum not unusual, while every engineer at all familiar with irrigation knows that such large figures are extremely rare for this day. A recent report of the Irrigation Division of the U. S. Bureau of Public Roads dealing with irrigation in northern Colorado shows, for instance, a stream duty on Cache la Poudre River, with over 200,000 acres irrigated, of only 1.67 acre-feet per acre. Again, the gross use under Turlock Canal, California, in 1904, as measured by the Department of Agriculture, was 8.34 acre-feet per acre, a figure that in the course of development has since been reduced to around 3 acre-feet per acre. In other words, it is only in unusual situations that irrigation engineers now think of the gross duty of water on well managed systems as exceeding about 3 acre-feet per acre, and then only for crops such as alfalfa that require heavy applications throughout a long growing season.

Lessened Conveyance Losses.—In methods of lessening conveyance losses of irrigation water, practice has likewise advanced materially, mainly through the constantly increasing use of concrete and cement linings and, in the case of farm distribution, through the ever growing use of underground pipe systems. Fifty per cent canal losses were taken for granted on some canal systems investigated by the Department of Agriculture in 1899, yet such waste would not be tolerated by the present generation. There are few canal systems of importance in the West on which at least the most porous sections have not been lined with either cement or concrete, whereas 20 years ago about the only examples of such practice were found on the two or three principal systems of southern California. Twenty years ago southern California was also practically the only irrigated section using pipe distribution systems on farms, whereas this method of carrying irrigation water is now not unusual in most parts of the West, and is the most usual method in many of our highly developed areas.

Method of Applying Water.—Take again the matter of methods of applying water to the land. In the earlier part of our period, for instance, few farmers gave attention to any method irrigating alfalfa other than the so-called "mountain" method of flooding from contour ditches, or, in California, the contour or rectangular check. The "mountain" method is still employed on perhaps 40 per cent of our alfalfa farms, and the contour and rectangular checks still find favor with some because of particular local conditions. On the other hand, with lands at all suited to its use, the border method of applying water to the crop is chosen above all others, because, if the "strips" are properly laid out, it is the most efficient method. Looking back to the year 1900, the only sections in the west in which the border method is known by the writer to have been in use are those about Woodland, California, and in the Salt River Valley, Arizona. Again, where shallow furrows and crude flooding were the most common ways

of irrigating orchards in the earlier period, regardless of soil type and with little attention given to evenness of distribution and prevention of excessive waste by a too deep penetration, there are now farmers in every irrigated section in the West who understand that the type of soil and slope must govern both the method of irrigation to choose and just how that method is to be applied if thorough and even distribution of the irrigation water without unreasonable and unnecessary waste is to be accomplished.

Perhaps the greatest advance of all that we can record in the matter of the use of irrigation water is in the scientific point of view with which the subject is now being studied by both the investigators of our Federal and State experiment stations and our better irrigators. For example, "What are the actual physiological requirements of the particular crop being irrigated?" and "Of the water necessary to be applied to a given soil to give even penetration to the desired depth, how much will be held in the soil against gravity, how much is actually available to the plants and how frequently is it necessary to re-apply water if a maximum product is to be obtained?" are typical questions we are now trying to answer. In other words, being fairly well informed on the physical means of spreading economically over the soil, we now want to know the relation of soil moisture to the physiological functioning of the plants and to the physical functioning of the soil. It is in such terms that we are beginning to interpret the term "duty of water" as understood by the engineer charged with designing irrigation works or the public administrator of water rights charged with allocating water to users; and it is in similar terms that we are undertaking to think out the best irrigation practice for different crops growing on different soils.

Hydro-Electric Power a New Croesus for Irrigation.—As is well known, the past 20 years have witnessed the practical completion of important irrigation development in which direct flow of streams rather than storage, has furnished the major portion of the water supply. Henceforth storage, and to a considerable extent very costly storage, must be the outstanding feature of new or enlarged irrigation enterprises. As every new need seems to create its own means of accomplishment, so a Croesus of nature has come forward to finance this new feature other than by charging it to the already overburdened backs of the farmers. We refer, obviously, to hydro-electric power, which, as an incident to irrigation construction or vice versa, is opening the door to irrigation extension that without its aid would not be economically possible. In California, to cite only a single state, every one of the major new irrigation enterprises under organization has the development of a large power output as an essential feature. Witness only the Merced Irrigation District. There we find a projected outlay for irrigation of $12,000,000 bonds for which have already been ungrudgingly voted by the people of the district, involving an acreage cost exceeding $60, if entirely charged to irrigation. But no such need exists; the irrigation district already has entered into a contract with the power company serving that territory, under which the return from power to be developed at the company's storage dam will carry the interest and sinking fund load of $9,900,000 of the $12,000,000 the enterprise is to cost. There is another project under organization in California by which hydro-electric power will play an even more essential part if the enterprise is to go forward; and we are all familiar with the overshadowing position hydro-electric power is to take in the proposed great Colorado River ventures.

Design of Irrigation Structures.—Within the past 25 years there has been an enormous change in the design of structures making up irrigation projects. We have not gone back to the time of the pioneers in irrigation, because it would not be fair to either the past or the present to contrast the work of the two periods. The pioneer was working in an emergency and with the only materials at hand.

The wooden structures of canal systems constructed prior to the organization of the U. S. Reclamation Service have been replaced by structures of reinforced concrete, but these less durable structures served their purpose in contributing to the education of the designinng engineer. When the Reclamation Service entered the field, its corps of engineers had two

extremes from which to draw conclusions as to the most acceptable types of structures and materials of construction — massive construction following Egyptian and Indian practice, and flimsy wooden construction of the then existing American practice. For obvious reasons they adopted a modification of the massive type. The standard set by them was the beginning of a policy of permanency in design, but economy was also made a major factor. The present standard of light reinforced concrete structures either cast in place or precast and assembled at designated points is the result of progressive steps and is also the result of splendid co-operation between members of the profession laboring for a common cause.

As an illustration we may compare the La Grange Dam built in 1894 with the Don Pedro built in 1922. In the former we have a structure 128 ft. high built of Ashlar masonry and for years after its completion considered one of the wonders of the engineering world. In certain respects, principally that of being an overpour dam, the La Grange Dam is still an outstanding feature. On the same stream and not many miles above the dam the same agencies have just completed the Don Pedro Dam, 283 ft. high, but built of concrete. The latter design permits of greater strength, more rapid construction and lower costs.

Pumping for Irrigation.—The prominence attained by pumping for irrigation is perhaps most strikingly emphasized by reference to the last federal census figures, which show that nearly one-half (46 per cent) of the lands brought under irrigation during the 10 years preceding 1920 are irrigated with pumped water. The capital invested for enterprises using pumped water had reached, in 1920, a total of nearly $140,000,000, or slightly more than the whole sum invested by the government in the works of the Reclamation Service. Even more impressive is the fact that the same total represented nearly 20 per cent of the cost of all irrigation works in operation in the census year.

While these comparisons take into account the many pumps irrigating rice in the fields of Louisiana, Texas and Arkansas, they also include the similar plants in California, which is far in the lead of the other western states in the number of its pumping plants and the extent of land irrigated by them. The raising of crops of marketable values justifying the expense of pumping even when lifts were high and the rapid extension of hydro-electric development, making accessible electric current for agricultural use at low rates were leading influences encouraging this growth. At any rate, in 1920 California had three-fourths of all the pumping plants used for irrigation. Motors and engines of other types enumerated by the California census had combined capacity of slightly less than 400,000 hp.; but so rapid was the continuing growth of pumping that in the spring of 1923, three years after the census date, a leading power company estimated that more than 500,000 hp. was represented in electric motors in use in the state for agricultural service, practically all of which was concerned with pumping for irrigation.

Pumping in Semi-Arid Belt.—While California and the gulf states have led in the development of pumping for irrigation, the semi-arid belt, notably western Kansas and parts of Nebraska and northern Texas have offered opportunities for irrigation by this means which are being taken advantage of more and more extensively. In western Kansas, irrigation pumping plants have been developed to a point where they may be said to be standardized. A few years ago there were almost as many types of plants as there were plants in operation, with a very wide range in the cost of installation and as great a range in the cost of operation. Today, in the valley lands of the state, there is but one type of plant being installed—an oil engine driven horizontal centrifugal pump on a battery of wells.

With this type of plant, contrary to popular opinion, the cost of developing a water supply is no higher than that of obtaining a supply from the gravity source. A pumping plant of this type large enough for the irrigation of 160 acres of land (having a capacity of between 2 and 3 cu. ft. per second) can be put in at an average cost of $2,000. In other words, the construction cost is about $12.50 per acre. This is very reasonable when compared to the cost of gravity

systems in the west, very few of which can be developed at this time under $50 to $100 per acre.

It has been generally supposed that the cost of pumping is such as to limit pumping irrigation to intensively developed districts, but with present practice in Kansas, the cost is such that the water can profitably be used with any ordinary system of general farming.

The importance of pumping irrigation to this section is made apparent by an estimate by the State Geologist of Kansas that there are more than 5,000,000 acres of shallow water land in the valleys of the state. Irrigation is proving to be profitable, not only in the western third of the state, but almost anywhere in the eastern part where there is water available. Of course, in the eastern parts of the state where the rainfall is greater, the amount of water required is less, but the function of irrigation is to make up the deficiency in rainfall; in other words, to act as insurance against drought. Where droughts of from 30 to 60 days occur during July and August, as they frequently do in sections of the state, the importance of irrigation becomes almost as great in the production of a large crop as does irrigation farther west where it is needed to produce most of the crop.

In 1900, fuel oil, steam and electrically driven centrifugal and deep-well reciprocating pumps as well as air lift pumps were all in use for irrigation, generally throughout the west. The centrifugal pump was used only for low heads to handle comparatively large quantities of water, while the reciprocating pump was used to raise water from greater depths but in smaller quantities. The motive power was poorly applied and often ill adapted to its task, and particularly in the case of the steam plants too expensive to be operated by the private individual.

Developments of Centrifugal Pump.—Although Euler, the mathematician, published a discussion of the centrifugal pump in 1754, it was not until after 1900 that the pump had been developed to a point where its true abilities could be appreciated. It was capable of not over 70 per cent efficiency and could lift water little over 20 ft. The pump did not come into its own until the electric motor and steam turbine, both high speed rotative power units, became firmly established in their present degree of mechanical stability, after the start of the 20th century. It is possible after these 20 years of improvement to design a centrifugal pump for almost any desired head, within reason, and for large installations to expect an efficiency up to 80 per cent at this head for a certain capacity. This was not the case before, when each manufacturer experimented with a little variation in blade shape from some other type, trying to produce a better impeller. Now the pumps are understood, and design, not chance, is the ruling factor in production.

The Deep-Well Turbine.—The deep-well turbine is a new development within this period. It is an application of the centrifugal pump in multiple on vertical shaft with the housing small enough to permit lowering inside of standard sizes of well casing. This pump handles a very much larger quantity of water than a reciprocating pump in the same casing could in the same time and does it very nearly as efficiently. It also eliminates the inertia forces of the reciprocating pump, which consumed so much of the power as the pump was lowered and the piston rod lengthened.

The air lift pump has changed but little in the last two decades and its use in irrigation is limited to a few sections and to special conditions.

The Power Unit.—The fact that both the true centrifugal pump and the deep well turbine pump are high speed machines has brought about the replacement of the steam engine and single cylinder low speed fuel oil engine by the electric motor.

The electric motor has replaced these units for other reasons, such as the fact that it is clean, silent, requires little attention, is compact, light and gives service ungrudgingly year after year. It, too, has been the subject of improving change so that the buyer is able to pick out just the size, type and speed that suits him best from any of several makes. It was characteristic of the first two or three years of the century that the motors were far too large for the pump and head so that an overburden of first cost was attached to the plants. The

availability of electric current for operating pumps has enormously increased the installation of small plants; the average motor so used is of less than 25 hp.

Sliding Scale Rate for Electricity.—Not the least of the changes since 1900 is the introduction by the electric power companies of the sliding scale rate as compared with the flat charge per year per connected horsepower. This latter charge made a burden of the electric charge where the plant was run but at intervals, so that the power consumption was not large. The charge was about $50 per connected horsepower per year and with the general tendency of applying a motor 100 per cent over-capacity to a given load, as was customary in 1900, and shortly thereafter, the power charge became exorbitant.

Fuel Oil Engines.—As there are still many places where electricity is not at hand, the fuel oil engine still maintains that field and the advancement that 20 years development has brought to these units has made them more efficient, lighter and more stable in operation. The development of the small true Diesel engine during this period has been noteworthy, and probably will increase in use in the irrigation field where a combination of increasing lifts and the most of electric power tends to make the expense of pumping prohibitive.

While the steam engine has progressed in this period, it still remains a slow speed unit. Its partner, the steam turbine, is not used to any degree in irrigation practice.

The inauguration of large irrigation projects with the corresponding demand for large quantities of water often producible by short lifts from streams has led to the introduction of the propeller type pump, which has in the last decade become an important factor in the efficient elevation of these large quantities of water. This is an adaptation from the earlier forms of screw pump which had the blades set at intervals along the shafting, which now has the blades assembled in one circle. Early forms of this pump were introduced for deep well use, having the blades at 5 ft. 10 in. intervals along the vertical shaft, but they met with the obstacle of lack of demand.

Results of Mosquito Control at Brunswick, Ga.

Reports coming to the Public Health Service from the quarantine station at Brunswick, Ga., indicate the success of mosquito control measures in that locality. During the months of April, May, and June, the report states, there was an entire absence of mosquitoes in Brunswick. This freedom from mosquitoes was due in part to the war made on mosquito breeding during the winter and spring months and in part to the prevailing temperature. The temperature up to the end of June was not conducive to productive breeding. With the advent of July, warmer weather and frequent rains produced conditions more favorable to mosquito propagation. The temperature for July ranged from 70 deg. to 90 deg. in the shade, with a mean temperature of 80 deg. F.

Up to the end of July no stegomyia were observed. If stegomyia were breeding, they were passive. During July there was practically an absence of mosquitoes in Brunswick and the neighboring vicinities. This situation, states Public Health Report of Aug. 24, was unquestionably due to the active measures taken by the civic and county authorities to suppress mosquito breeding. The only mosquitoes observed during the month of July were the Culex and Anopheles, which appeared during the week of July 28. This invasion was mild, and measures were immediately taken to suppress further invasion and to keep the city free from malaria.

This work of malaria suppression and control in Georgia is being carried on under the direction of the sanitary department of Brunswick and the local board of health. Experienced officers are in charge. Ample help and facilities have been provided for the abatement of all mosquito-breeding places and the destruction of all larvae. Sanitary inspectors are employed to see that all property owners and tenants keep their property free from standing water exposed in such way as to provide a breeding place for mosquitoes.

At the end of July the status of the public health in Brunswick and, in fact, throughout Glynn County, was remarkably good. There were but few cases of malaria, still fewer cases of typhoid, no dengue, and no diseases of a quarantinable kind.

Hydrant Connections for Fire Engines

Service Required of Hydrants, Effect of Pumping Engines and General Practice Regarding Outlets Described in Paper Presented Sept. 20 at Annual Meeting of New England Water Works Association

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Fire hydrants should be designed installed to give the greatest possible service in fighting fires, consistent with reasonable costs of installation and maintenance, and with due regard for the integrity of the water works system. The water ways in hydrants should be of sufficient size to prevent material losses in water pressure due to friction velocity head and other causes. For the purpose of connecting hose lines direct to the hydrants, two 2½ in. nozzles, or outlets, are commonly provided. In municipalities where the fire department is equipped with steam fire engines or motor-driven pumping engines, the usual practice is to install hydrants having in addition to the 2½ in. hose outlets, a 4½ in. outlet to which the suction hose of the pump can be attached.

Desirable practice in this regard is indicated by the requirements of the National Board of Fire Underwriters. In the "Standard Schedule for Grading Cities and Towns of the United States With Reference to Their Fire Defences and Physical Conditions," published by the National Board of Fire Underwriters, is found the following:

"Hydrants shall not have less than two 2½ in. outlets and also a large suction connection where engine service is necessary."

Where the pressure in the distribution system are sufficient to permit satisfactory streams direct from hydrants, pumping engines may not be required by the underwriters' schedule but the proportion of municipalities where pumping engines are not used is decreasing. The modern motor-driven pumping engine with its greater speed of travel is being more generally adopted by fire departments than was the case with the steam fire engine. Furthermore, there appears to be a tendency to decrease pressures in distribution systems to the point of furnishing satisfactory service for domestic needs, and to throw the burden of developing fire stream pressure on the fire department apparatus.

Therefore, it may be expected in the near future that there will be a more general use of pumping engines by fire departments, and, accordingly, hydrants, connections and distribution systems should be designed with this fact in mind.

Service Required of Hydrants and Effects of Pumping Engines.—An example of the severe tests to which hydrants in the larger cities may be put is illustrated by incidents at a four-alarm fire on Congress Street, Boston, July 18, 1923. The writer is indebted to Mr. George H. Finneran, superintendent water service, Boston, and Mr. E. M. Byington, superintendent of construction, Boston Fire Department, for the following details:

One hydrant of the Boston post type, having one 2½ in. hose outlet and two 4½ in. steamer outlets, during the early stage of the fire, had a connection by means of a large suction hose from one 4½ in. outlet to a steam-driven reciprocating engine of about 750 gal. per minute capacity. The 2½ in. outlet was connected by means of a large suction hose and reducer to a motor-driven rotary pump of about 1,000 gal. per minute capacity. With these two engines in operation, there was a noticeable vibration in the hydrant barrel. This hydrant is set in a chamber, and the hydrant barrel is not supported at the street level, the only rigid support being at the base and at the connection with the main. Additional streams were required, and the so-called "horseless engine" was connected to the other 4½ in. outlet. This engine is steam propelled, and has a steam-driven reciprocating pump of about 1,100 gal. per minute capacity.

There is no record of the actual rate of flow of water through the hydrant, but the rate of draft was probably at least 3,000 gal. per minute with the three engines as operated. Under these conditions, the hydrant barrel swayed violently, and although various means were tried to provide support, it finally became necessary to

disconnect the "horseless engine" to prevent wrecking the hydrant.

A large air chamber was then brought to the scene and inserted between the pump suction and the suction hose leading to the hydrant outlet. This chamber had a dome top, was 10 in. in inside diameter, about 28 in. high, and was restricted to 4½ in. in inside diameter at the base, where the connections were made. The installation of this air chamber reduced the vibration in the hydrant considerably. It was found by trial that the chamber was most efficient when attached to the pump suction rather than to the hydrant outlet.

The water mains supplying this hydrant were ample in capacity, as shown by the fact that the pressure did not drop appreciably during the fire (see Fig. 1) but the hydrant lateral was only 6 in. in diameter and the flow in the hydrant pot was restricted by the valve, which opened in the direction of the flow of water. This was the second instance of trouble with this hydrant under similar conditions. In fact whenever the "horseless engine" has been used with other engines at a large fire severe vibration has been caused at the hydrant.

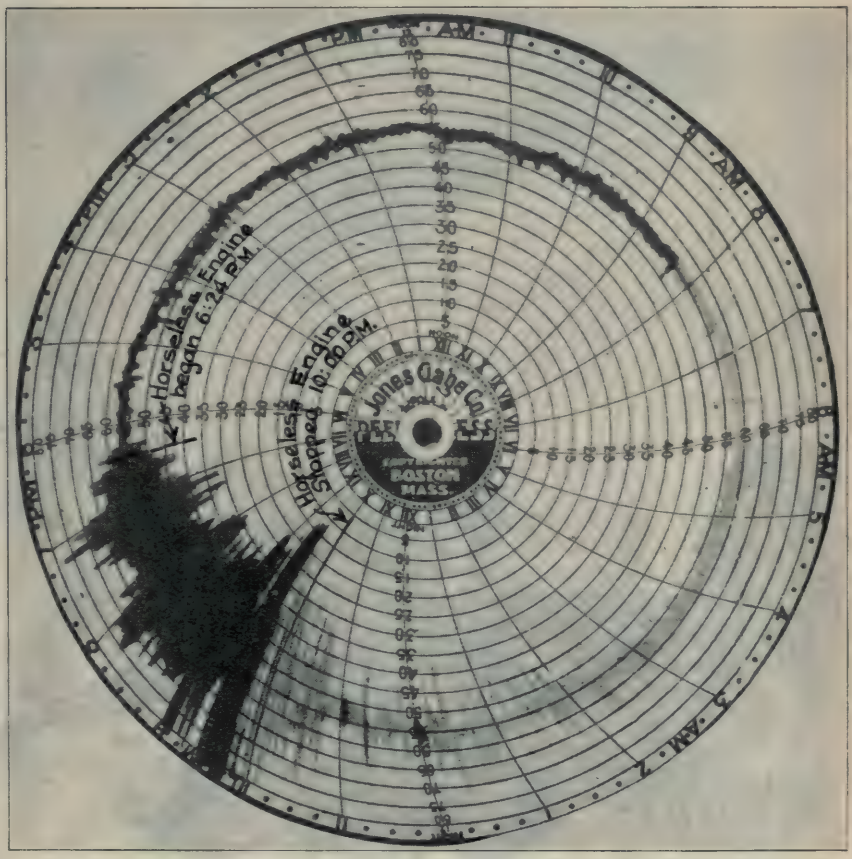


Fig. 1—Fluctuation in Water Pressure in Distribution Mains Caused by Water Hammer from Pumping Engines, Congress St., Boston, Fire July 18, 1920.

The Congress Street fire, which was located in a 5-story warehouse in a high value, wholesale district, outside the limits of the high pressure water system, furnishes an interesting subject for study of the demands on the water distribution system during a large fire. Chief John O. Taber kindly furnished details of the fight-

A Holiday Anachronism

Anachronism (*an-ak'ron-ism*), *n.*
"An error in the order of time, hence any error in the misplacement of persons or events in point of time. — *Universal Dictionary.*"

Christmas was the great holiday season of the Middle Ages—perhaps even more so than with us now. The bringing in of the Yule-log, which would burn for a day on the gigantic hearth, was a ceremony.

But the great, crying need of the Middle Ages was not so much for Yule-logs, though the castles were cold, as for sanitation. Lack of sanitation brought its terrible plagues. If the men could have hauled into position lengths of Lock Joint Pipe, the latter would have meant much for their happiness. They would have brought adequate water supply and sewer drainage every day, every year.

How fortunate are we to live in the age of perfected, economical sanitation, health and comfort—which means the age of—

Pressure Sewer

LOCK JOINT
Reinforced
Concrete Pipe

Subaqueous Centrifugal

8 Rutledge Ave., Ampere, N. J.

ing of the fire. A description of the fire will be found in "Fire and Water Engineering," Aug. 1, 1923, p. 217.

There were 16 engines in use, connected to nine post hydrants and two Lowry flush hydrants, and furnishing a maximum of over 12,000 gal. per minute of water to 18,900 lin. ft. of hose. The average pump pressure was 143 lb. per square inch, and varied from 120 to 200 lb. per square inch. The apparatus and equipment was handled by 240 firemen.

A short distance from the scene of the fire in one of the fire department engine houses was a recording pressure gage, which made an interesting record of the water hammer in the distribution mains referred to above. This is shown in Fig. 1. The first alarm was sounded at 6:07½ p. m. The first engine began to pump at 6:10 p. m., and the "horseless engine" began to pump about 6:24 p. m. and was shut down about 10:00 p. m. Its effect was very marked. After the air chamber was installed it was again used on watch lines for about 39 hours.

At a fire in Charlestown, where the "horseless engine" was used, the vibration was sufficient to loosen the four bolts which hold the base of the hydrant, and the hydrant barrel came off while the engine was working.

At a fire in Brighton two steamers of the reciprocating pump type were attached to the two 4½ in. outlets of a Boston post hydant. One of the steamers was supplying one line of hose. The other steamer for some reason was not working. A motor-driven pumping engine was then attached to the 2½ in. outlet, and four lines of hose were attached to the pump, each line supplying 1¼ in. nozzles. The pump was operated showing 12 in. of vacuum on the suction, but it was impossible to get satisfactory service, and it was found necessary to remove one of the hose lines to one of the steam-driven engines, leaving three lines of the motor-driven pump attached to the 2½ in. outlet. From this observation and others, Mr. Byington is of the opinion that three streams of perhaps 250 gal. per minute each, or a total of 750 gal. per minute, is about the maximum rate at which water can be satisfactorily drawn by a pumping engine through a 2½ in. hydrant outlet.

Fortunately, experiences like the foregoing are not of frequent occurrence. Normally, a hydrant is called upon to supply water for two or three lines of hose at maximum rate of perhaps 600 to 750 gal. per minute or less.

At these rates of discharge and where ample pressure is available, the size of outlet used and method of connection are not matters of great importance.

In districts where the ordinary pressure maintained in the distribution system is 75 lb. per square inch or over, it has frequently been the practice to install hydrants with hose outlets only, and to omit the steamer outlet. This seems to the writer ill advised for two reasons:

First, in case of a serious conflagration a larger number of fire streams than usual will be used, and the pressure in the entire district will be materially reduced—probably to the point of requiring engine service to maintain satisfactory fire streams. For the ordinary fire, of course, this is not so.

Second, it occasionally becomes necessary, due to unusual conditions, to connect hose lines to a hydrant located some distance from a fire, with the result of lines 1,500 to 2,000 ft. or more in length. Under such conditions even 90 lb. per square inch pressure will not give satisfactory service, and the services of a pumping engine will be desirable to raise the pressure, perhaps, up to 250 lb. per square inch. Communities that at present have no engines of their own occasionally require help from outside, and furthermore, it will not be many years before pumping engines will be used by practically all fire departments.

Therefore it would appear that the slight additional cost necessary to provide at least one steamer outlet, is justified.

Loss of Head in Hydrant Outlets.—The National Board of Fire Underwriters in the "Standard Schedule," page 32, specify:

"Hydrants shall be able to deliver 600 gal. per minute, with a loss of not more than 2½ lb. in the hydrant and a total loss of not more than 5 lb. between the street main and outlet * * *".

Newcomb's Holyoke hydrant tests reported in Jour. N. E. W. W. Assoc. Dec. 1907, page 421, show for the hydrants without independent gate valves on the outlets and with bar-

rels 5 in. in inside diameter and greater, losses due to friction varying from 1.21 to 3.21 lb. per square inch at a rate of flow of 500 gal. per minute with one fire stream. For the hydrants having independent gate valves on the outlets, the losses due to friction varied from 2.92 to 8.28 lb. per square inch.

The loss of head due to friction of flow of 600 gal. per minute through a 2½ in. outlet averages about 2 or 2½ lb. per square inch, if there is no independent gate valves on the outlet, and for a 4½ in. outlet only about one-tenth as much, according to Mr. George W. Booth, Chief Engineer, The National Board of Fire Underwriters.

600 gal. per minute flowing.

2½ in. diameter outlet, velocity 39.4 ft. per second, velocity head 24.14 ft.

6-in. diameter barrel, velocity 6.8 ft. per second, velocity head 0.72 ft.

Difference in velocity head=24.14 —0.72=23.42 ft.

½ lb. per square inch is equivalent to 5.8 ft. head.

5.8 ft. due to friction+23.4 ft. due to velocity=29.2 ft.

To the friction loss of 2½ lb. per square inch must be added the head necessary to develop the required additional velocity of the water in the outlet over that in a 6-in. hydrant barrel amounting to 23.4 ft., thus making a total head of 29.2 ft. necessary in the main at the elevation of the center of the hydrant outlet. While some of this head may be recovered after passing the outlet, particularly if an increaser is used between the outlet and the suction hose, the most of it is probably lost. For higher rates of flow, the loss of head will be greater. These losses appear sufficient to justify wherever practicable the use of the steamer outlet for engine suction rather than to make the connection by a Siamese coupling to two 2½ in. outlets. It may be that where ample pressure is available, the loss of head suffered by using a larger suction hose with a reducer connected to one 2½-in. outlet is not sufficient to offset the advantage of handling the smaller coupling. If, however, there is an independent gate valve on the outlet, the loss of head is likely to be objectionably large.

General Practice in Regard to Hydrant Outlets.—The following comments by Mr. George W. Booth are the results of the observations of the engineers of the National Board of Fire Underwriters:

"Our engineers are in frequent touch with fire chiefs and water works superintendents and have an excellent opportunity to find out their opinions and to learn of local conditions.

"We have never heard of a case where damage to the hydrant or to the main resulted from the use of the large outlet. There is a possibility of the hydrant nipple being jarred loose as a result of vibration transmitted from the steamer or the motor pumper especially if a stiff suction is used; however, this possibility is just likely to occur with the 2½-in. outlet as with the larger one.

"Our engineers report that practically all fire chiefs in the east use the large outlets when provided and would very much object to the installation of hydrants not having large outlets. In the middle west the testimony is that large outlets are generally used when available. There are, however, many municipalities which have water works designed to carry a high enough pressure during fires to supply streams direct from hydrants, which have therefore only the 2½-in. outlets. Now that the use of pumpers is becoming more common, there is a tendency to reduce pressures and this in our opinion has some advantages.

"In many of the larger cities, Detroit and St. Louis, all or nearly all hydrants have none but large outlets.

"While it is true that the function of the fire engine is to furnish water at the necessary pressure, it is also true that the capacity of the pumper is primarily determined by the horse power of the engine and every pound of pressure that can be applied to the suction side of the pumps increases the capacity of the pump, and friction losses which can be readily eliminated should be avoided. Even though the pressure at the hydrant may be normally sufficient to furnish adequate supply through a 2½-in. outlet the local friction losses in the mains which result from the use during a large fire of excessive quantities of water within a small area, will so reduce the pressure that a larger outlet is required for adequate supply.

"To sum up, I believe there is no valid argument against the use of the

4½-in. outlet and a number of good arguments in its favor."

In response to the writer's request, Mr. E. V. French, President of the Arkwright Mutual Fire Insurance Company, ascertained the views of their engineers and wrote the following comments:

"We have been unable to find any experience which would indicate that a 4½-in. hydrant outlet constitutes a hazard to either hydrants or distribution systems. A 4½-in. hard suction pipe would probably transmit somewhat more vibration from an engine than a 3½-in. or 2½-in. hard pipe but we should not expect the difference to be serious or of any real importance with a properly designed hydrant.

In cities with good water pressures, such as Woonsocket, R. I., engines take water sometimes through ordinary 2½-in. hose using two hydrant outlets. In New Bedford experience has shown that sufficient water could not be obtained with two 2½-in. connections if the water pressure in the mains fell much below 50 lb. so that in all cases in New Bedford, the 4½-in. suction connection is used. There have been cases where a single 2½-in. soft hose connection has collapsed under the suction produced by the engine.

In some cities 4½-in. hard hose is used with a reducing coupling which can be attached to the 2½-in. hydrant outlets, thus restricting the inlet for only this single point and consequently obtaining a good deal more water than if the suction pipe was 2½-in. all the way. However, in the majority of cases in this vicinity (Boston) at least, 4½-in. hard suction pipes are used."

John S. Caldwell, Engineer, New England Insurance Exchange, expressed his views on this subject as follows:

"We have never found in our work here in New England any sentiment among either water works or fire department officials which would tend to discourage the installation of the large connection.

"Relative to the vibration which may be experienced in the hydrant due to the connecting to a modern motor pumping engine through the 4½-in. connection, would state that I do not believe this is so, as we would expect more vibration from the old reciprocal type of pump when in use with a steamer than what we would get with the more modern machine. Of course, it is common practice for fire departments to use a 4½-in. by 2½-in. reducer for connection to engines where only a small quantity of water, like a single stream, is desired but when the engine is required to work up to capacity, unless they happen to be on a hydrant with exceptionally good pressure, they very frequently are unable to get ample capacity through 2½-in. connection.

I think I am perfectly safe in assuring you that there is no sentiment here in New England, as we have observed the conditions that would tend to discourage the installation of the larger engine connection and, as stated above, I believe the opposite is true, namely that there is a movement on foot in the replacement of existing hydrants with ones having larger connection, and in our grading of the fire protection throughout the different cities and towns we make a deficiency charge for the lack of engine connections on hydrants."

Chief Ross B. Davis, Bureau of Fire, Philadelphia, by courtesy of Mr. S. M. Van Loan, Deputy Chief, Bureau of Water, contributed the following:

"Our hydrants which have a 4-in. outlet and 4½-in. suction hose permit us to take three and four lines from the one steamer and we would never allow over two lines to be taken from a pumper or steamer with a 2½-in. suction, unless reducing the tips of the nozzles, and that reduces the volume."

C. M. Saville, Manager and Chief Engineer, Board of Water Commissioners, Hartford, Conn., stated that all of the hydrants being installed in Hartford, Conn., have two 2½-in. hose outlets and one 4½-in. steamer outlet.

Wm. W. Brush, Deputy Chief Engineer, Department of Water Supply, Gas and Electricity, New York, wrote:

"Our standard hydrant has one 2½-in. and one 4½-in. outlet. We have never had any complaint that has come to my knowledge of difficulty through the use of the 4½-in. steamer outlet. I personally believe that it is a mistake to use small outlets, that there is no danger to the hydrant with the 4½-in. outlet, and that with the increase in the size of the pumping engines the standard hydrant

should carry a 2½-in. and 4½-in. outlet."

George A. Carpenter, City Engineer, Pawtucket, R. I., reports that there are no hydrants in the city with 4½-in. steamer outlets. This appears to be contrary to the practice of most New England cities. Inquiries by the writer in Indianapolis, St. Louis and Dayton, where large steamer outlets are generally provided, failed to disclose any instance of trouble which could be attributed to the use of such outlets.

Support for Hydrants.—The hydrant outlets must be securely fastened to the hydrant barrel, which fact is recognized by the manufacturers of high grade hydrants. Not all water works builders, however, recognize the necessity of securely fastening the hydrant barrel to the lateral and main to prevent its being blown off. Where the main pipe is but a short distance from the hydrant, chains or bolts may be used to secure the hydrant. Concrete blocks cast behind the hydrant have also been used. Where dependence is placed on earth backfill or loose rock fill, the hazard to the hydrant is much greater. It is true that many hydrants have been set without special precautions being taken to properly support them, but it cannot be considered good practice. Earth backfill, well rammed, will provide sufficient lateral support except at the back. Where the hydrant is set in a heavy pavement, or concrete sidewalk, ample lateral support is ensured, but such support should not be relied upon to secure the base of the hydrant. If the hydrant is adequately supported and of first class design and manufacture, it may safely be depended upon in time of emergency.

Conclusions.—The use of 4½-in. steamer outlets on hydrants, in addition to two 2½-in. hose outlets, is desirable where pumping engines are likely to be used. In the larger cities, it is probably better to provide two large steamer outlets and only one 2½-in. outlet.

The trend of good practice appears to be toward a reduction of the pressures maintained in distribution systems to provide for domestic service, with dependence on fire department pumping apparatus for fire stream pressures.

Steamer outlets should be provided even where the ordinary pressure is ample for two hose streams, to make possible the draft of water at higher rates with a pumping engine in case of a serious fire or other emergency.

The distribution system should be capable of delivering water to the hydrants at rates consistent with the demands of modern fire fighting methods.

During a serious fire, hydrants may be subjected to considerable vibration due to heavy drafts of water. To prevent failure in such a critical time, the hydrants should be of heavy construction and firmly supported. Special precautions should be taken to prevent the hydrant blowing off from the lateral at the base.

According to the Underwriters' rating a municipality will be penalized if there is a deficiency in steamer outlets, where engine service is required.

It is desirable to install steamer outlets even where a pressure of 75 lb. per square inch is ordinarily maintained, to provide for engine service in emergency.

There appear to be several good reasons why at least one large steamer outlet should be provided on every hydrant in a standard pressure water distribution system, and no valid reason against providing such an outlet.

Public Water Supplies in Minnesota.—There are at the present time nearly 400 municipalities in Minneosta maintaining public water supplies. Of this number only 38 are dependent, either entirely or in part, upon lakes and streams as a source of supply. Twenty of these surface supplies receive treatment of some kind before the water is pumped into the distribution system, and in 18 cases the water is used without treatment of any kind.

New York Board of Water Supply Has Spent $159,000,000.—The expenditures of the Board of Water Supply of New York City for all purposes from the date of its organization in 1905 to Dec. 31, 1922, was $159,392,946, of which $137,543,175 was disbursed on account of actual construction, $16,429,716 was charged to supervision of construction, and the balance was expended for preliminary surveys, maps, plans, etc.

Ice Problems of Hydro-Plants

Suggested Studies for Their Solution Outlined in Paper Presented at Annual Meeting of American Society of Civil Engineers

By W. T. WALKER
Construction Superintendent, Northern States Power Co., Minneapolis, Minn.

Up to the present time when handled at all this subject has been considered one of the trifling matters and has usually been passed by and left up to the operating crew to be taken care of in such a manner as they might see fit. As the designing hydraulic engineer is usually a person of much more training and far greater experience than the operator in charge of running these plants it is obvious that the designer should furnish the means of solving these problems and then instruct the one who is left to do the operating just how to use the means which have been provided.

In discussing this subject with individual engineers the usual objection offered to making any attempt to reduce the solving of the problems to a science, is that every case is different and that it is impossible to predict just what will happen when ice is running in large quantities. I am confident that when the subject is studied by capable engineers that general principles can be laid down which will be of the greatest assistance in designing structures best adapted to take care of the conditions to be met.

Frazil Ice Shuts Down Power Plant.—About seven years ago shortly after the middle of November we were visited by a sudden cold snap, the temperature at one of the hydro-plants on the Mississippi north of Minneapolis on the first night of this cold snap was about 5° below zero. Suddenly there came a crash as if out of a clear sky. The entire plant immediately shut down. None of the operators on watch had any idea of what had happened.

On investigation it was found that all the racks in front of operating wheels had suddenly become completely closed with frazil ice and not being designed to stand a head of 25 feet of water a large portion of them had suddenly collapsed with the resulting crash.

By the time repairs had been completed it had entailed an expenditure of several thousand dollars and that expenditure was a small amount when compared to the loss of power output.

After a study which involved the theory of the formation of frazil ice it was decided to build a house over the forebay and provide enough heat to keep the temperature in this house above 32°. Never since that day has there been the slightst trouble with frazile ice.

I am citing this instance merely as an example of what can be accomplished by the engineer with a little study and investigation. Of course the accident had to happen before it could be investigated.

One more instance which will illustrate the interesting phases that this subject may assume. At one of the plants in which I am interested there has been considerable discussion and a number of plans made for installing ice breaking cribs at a cost running well into six figures. What the action of these cribs would be if installed is very much a matter of doubt.

It is my opinion that more can be accomplished by proper operation of the means thus far provided than to spend this large amount of money to gain doubtful results. In order, however, to learn the proper method of operating a complete study should be made of similar conditions and learn what is being done by other operating companies. Such studies as this and a multitude of others are required to solve the various problems and finally arrive at conclusions covering the various situations.

I will merely suggest some of the studies which would prove interesting and valuable from the designing engineers as well as operating engineer's point of view.

Type of Control Gates Best Adapted to Conditions Encountered.—Among these I will mention: Tainter gates, vertical lift gates, vertical submersible gates, automatic submersible gates.

Methods of Relieving Gates of Ice Pressure.—One unique method for accomplishing this suggestion was adopted I believe first at Keokuk Dam, and consists of placing a few feet below the surface of the water a pipe with a number of small openings and to this attaching an air compressor. The bubbling caused by the air passing through these openings keeps the

ice from in front of the gates. This method has been adopted by several of the plants which I am interested in with very satisfactory results.

The Method of Maintaining Gates in Operation During Freezing Weather.—Under this subject may be mentioned housing in gates, and placing heat inside of the housing. There has been suggested a heating element be embedded in the supporting piers to which could be attached steam heat. So far I am aware this has not been tried.

Ice Breaking Piers.—Ice breaking piers should be a matter of serious study. This study should include the conditions where piers are adaptable and where they are not. It is quite evident that you do not wish to place an ice breaking pier in water over 20 or 25 ft. deep. It is also quite evident you do not wish to congest your river channel in such a way as to cause ice gorges. The general design of these piers should be a matter of careful study as should also be the methods of anchoring, size, location, etc.

Frazile Ice.—There should be made studies in frazile ice, its causes, and methods of eliminating possible trouble. I have already mentioned one instance of where frazil ice has been eliminated very effectually. Another case which I may cite is this. In some of our large steam plants where the amount of water to be handled is altogether as much as in some of our water powers, that is the water for condensing purposes, we have had considerable trouble with frazil ice clogging the screens of the condensers. We have eliminated this by so arranging our discharge tunnels as to recirculate a portiton of our condensing water if we so dispose. Just enough has been recirculated to melt the frazil ice but not enough to materially bring up the temperature of the circulating water.

Ice Gorges.—In studying ice gorges one must not overlook the fact that forges below your power house may cause just as much financial loss as those which form above, due to the fact that your tail water may be so raised as to very materially reduce your operating head.

Ice on Canals.—A very interesting study and one in which little or nothing has been done is the effect of a sheet of ice over canals. It is evident that where such a sheet of ice forms the carrying capacity of the canal is going to be materially lessened or the sheet of ice may continue to raise until the sides of canal may be badly damaged.

Investigations should be made as to anchor ice, its causes and effects.

Shore Ice.—One problem which I have not touched on could be made a matter of interesting study. After the general run of ice has passed we frequently have heavy flows of ice which has formed along the shore but does not move until the streams have risen to such an extent as to dislodge it. This ice brings with it trees, bushes, logs, and such like. It is difficult to prepare for and difficult to handle this situation.

Permit me to suggest that the American Society of Civil Engineers recognize this subject as a matter of sufficient importance to appoint a committee of its members to study the various phases of the problem and as a culmination of their work publish a report of their investigations which report would contain all the information of value collected, together with drawings, sketches, photographs, etc., which would illustrate their findings and recommendations.

I am sure such a committee would find much hard but interesting work but they would also produce a result of much benefit to the engineering profession.

Sewage Disposal Methods of 83 Cities.—According to a survey of 83 cities of 100,000 population and over, made in 1921 by the committee on municipal health department practice of the American Public Health Association, 61 cities dispose of their sewage directly by simple dilution into the nearest river or body of water. Of the remaining 22 cities which have some form of sewage treatment, 5 dispose of their sewage by dilution after passing through coarse screens. Excluding these 5 cities in which screening only is done, there remain 17 cities which operate more elaborate treatment plants designed to remove and digest the finer particles of suspended matter and to reduce the putrescibility of the sewage. Of these 17, however, the treatment works of 6 cities are designed to treat only part of the total sewage of the city.

Quarterly or Monthly Reading of Meters

Advantages and Disadvantages Set Forth in Paper Presented at Convention of Tri-State Water and Light Association

By J. E. GIBSON
Manager and Engineer, Water Department of Charleston, S. C.

Upon the granting of the franchise to the water company in 1903, the schedule was that of the old flat rate system, which was based upon a quarterly rendition of bills in advance of the service; that is, at the beginning of each quarter the consumer was billed for the water rate for the ensuing quarter based upon the number of fixtures, frontage and size of house. Very little or no complaint was made to the advance payment of the quarterly charge. Contracts were supposed to be made for an entire year, and it was expected that the consumer would take water for 12 months.

There was a clause in the franchise which permitted a consumer on demand to purchase a meter and take water by meter rates, which were also prescribed, based upon the daily consumption in 1,000 gal. A like privilege was granted the water company, in that if they suspected a party of wasting water, having poor plumbing or using it for other purposes than that contracted for, they had the privilege of installing a meter and charging for water at meter rates. The result of this schedule was that those people who were thoughtful, soon realized that they were taxed an excess amount to cover possible wastage and loss, and began to demand meters, more particularly the commercial concerns. At first there were few meters in use, and it was a simple matter for one man to go out and read these meters on the first of each month.

With large consumers of water such as railroad companies, with the possibility of stoppage of meters involving large pecuniary losses and causing argument as to the proper adjustment of bills, the practice of reading meters monthly was justified and is still followed.

The City Takes Over the Water Works.—This was the condition of affairs when the commission took over the operation of the plant at the time of purchase by the city in 1917.

Abuses had grown up during these years of private ownership due to political conditions. Sixty per cent of the consumers were obtaining water through meters, some having yearly contracts, others monthly contracts. Those having yearly contracts were granted the privilege of offsetting high consumption during one period of the year against low consumption at another period. Those having monthly contracts were denied this privilege, which caused friction and discontent. The remaining 40 per cent of the consumers were being supplied under the old flat rate system of contract.

An analysis of the total water pumped and delivered to the distribution system and a systematic reading of the small meter supplying the metered consumers, showed that the 40 per cent of unmetered consumers were using over 60 per cent of the total water pumped. A census of the city, of the number of dwellings therein, showed that there were approximately 12,000 properties that should be consumers of water and of these there were existing on the books only 6,500 consumers of water. How and where did the remaining 5,500 properties get their water supply? There were two sources, wells and cisterns which had been condemned by the health department as insanitary and likely to cause sickness and epidemics, and secondly, a surreptitious taking of water through the taps of neighboring properties. A large percentage of these properties not connected to the water works system were owned or at least occupied by the colored population.

The New System of Rates Adopted.—The question of municipal ownership and operation was a doubtful experiment, and in my opinion our commission wisely decided to disturb the customs and rates in force to the least possible extent, and therefore adopted our present schedule of rates. These, while not the most scientific, are equitable and just.

1. We discarded the yearly contract, feeling that it was not equitable, and if required, and not enforced, would grow into an abuse.

2. That a three months' contract was equitable and imposed no grevious hardship, should circumstances compel one to surrender his contract after a few weeks of service, as the minimum charge of $3 would not more than cover the cost of setting meter, removing same, reading and billing for a short period.

3. It would permit those people who spend the summers away from the city to close their houses, cancel their contracts and have the water shut off, thus eliminating the danger of high bills due to leaky plumbing during their absence. It further gave them the possibility of equalizing the low consumption during one month as against high consumption during another month of the same quarter.

The minimum rates provide an ample supply of water to cover all legitimate needs of the average family without offering a premium on a parsimonious use of this essential commodity. In other words, it is possible for the average family in the city of Charleston to have all the conveniences of modern plumbing, such as kitchen sink, toilet, bath room, basins and an ample supply of water for $3 a quarter; further, it places this service within the reach of the most humble citizen.

That this action on the part of the commission was wise is evidenced from the satisfaction it has afforded. Consumers have increased from a little over 6,500 to over 9,000 in the five years of municipal ownership. The entire city has been metered, the amount of water accounted for has increased from 55 per cent in 1917 to an average of 85 per cent in 1921-1922. The difference is accounted for by the water used for municipal sewer flushing and fire purposes. This percentage of accounted for water is above the average of American cities, and is exceeded by a few only.

A Study of Monthly Reading and Billing.—The only complaint that has been made against the schedule as adopted is the payment of high bills owing to defective or poor plumbing, and some of our citizens feel that if the water department should read meters and bill monthly, they could thereby check up and keep tab on the condition of their plumbing more accurately than if read quarterly.

A careful study of water bills justifies the subconscious deduction of our employes, that consumers pay little attention to their increasing water bills until they reach a very high percentage of the normal consumption, and even then do not take the necessary precaution to see that their plumbing is properly repaired, as is evidenced by a second and third period of abnormal consumption.

How much less attention will be paid to the increasing consumption when the readings are made monthly, and the increased increments therefore smaller? Further, a leak amounting to so little as 1 gal. per minute taking place in a yard toilet (usually installed for the convenience of servants, and therefore not directly under the observation of the thoughtful members of the family), will account for a bill of $10.50 in 30 days.

Using the information obtained in the study of bills, and assuming that $10 is a reasonable and not an exorbitant bill and that the arithmetical mean of these divisions represents the average amount of money involved in each bill, we find that the following bills were rendered in excess of $10 per quarter:

2,983	Bills rendered for av. amount of	$12.50
961	Bills rendered for av. amount of	17.50
382	Bills rendered for av. amount of	22.50
375	Bills rendered for av. amount of	37.50
64	Bills rend. not in excess of amt. of	75.00

Using the limit of a non-exorbitant bill as $10 per quarter, and the information on heavy consumption, together with the possibility of a small leak, as hereinbefore mentioned, it is a reasonable and fair conclusion that threre would be no saving effected to consumers where their bills are only 150 per cent in excess of $10 or $15 per quarter.

Again, assuming that every dollar in excess of this maximum bill of $15 could have been saved the consumer, we find the following:

2,983	Bills at an average of	$12.50	less	$15.00	max. No saving.	No saving
961	Bills at an average of	17.50	less	15.00	max. Saving.....$ 2.50	$ 2,402.50
382	Bills at an average of	22.50	less	15.00	max. Saving..... 7.50	2,865.00
375	Bills at an average of	37.50	less	15.00	max. Saving..... 22.50	8,437.50
64	Bills at an average of	75.00	less	15.00	max. Saving..... 60.00	3,840.00

A total saving during the three years and nine months of.....$17,545.00
An average annual saving of.....$ 4,690.00

The above assumptions are certainly liberal and I feel that practically they cannot be obtained, owing to the frailties of human nature, and knowing how soon we lose sight of the newness of the "broom." However, the consumer is fully entitled to the benefit of the doubt in the case.

The next phase of the subject is, how much will it cost all of the consumers to effect this saving to 1 54/100 per cent of the consumer? Before proceeding to this portion of the discussion, let us consider some of the duties of the commission to the public.

The Primary Duties of the Water Commission.—It is undoubtedly the duty of the commission to operate the water works plant efficiently:

1. As to the quality of the water.

(a) For drinking and cooking purposes.

(b) For laundry and general household use.

(c) For manufacturing purposes.

2. As to quantity of water.

(a) For sanitary purposes.

(b) For fire protection.

3. As to extension of mains and conduits and plant to supply the growing needs of the city (for without an adequate water supply no city can grow, however fortunately she may be otherwise situated and endowed).

4. Economically upon a business basis.

(a) That the citizens may be taxed equitably and justly for the service rendered them and that none receive privileges not enjoyed by all.

(b) That all moneys due be collected promptly and all purchases of material and supplies be honestly made at lowest obtainable prices, quality alone for service intended being considered.

(c) That all expenses of operation, maintenance, sinking fund, interest on bonded indebtedness or cost of plant be paid from the income collected and that any excess income above these expenses be set aside as a surplus out of which future extensions, improvements to plant and water supply facilities shall be made.

(d) To employ an efficient personnel to conduct the operations of the business with the least number of persons that there may be a minimum of inefficiency, soldiering, slackness and indifference.

It is well recognized that the most efficient organization is the one having the smallest personnel to accomplish the work with accuracy and dispatch. With our present system of quarterly reading, the work has been so systematized that each employe has a definite portion of the work to perform, and each is thoroughly acquainted with the work of the other members of the organization, with the result that there is thorough team work. There is a minimum number of units in each division of the work, and, therefore, the responsibility for error can be placed directly upon the one at fault. This has resulted in a very high degree of efficiency, and it will be neecssary if monthly reading of meters is adopted, to increase the number of employes, with the consequent and inevitable loss in efficiency due to increased number.

Increased Cost Due to Monthly Reading.—Should we adopt monthly reading of meters, we estimate that it will require the following additional employes:

An assistant to the contract and new business clerk.

Three additional meter readers.

Three additional clerks in the accounting department.

One additional man for shutting off and turning on water.

Further, stationery supplies such as bill heads, delinquent notices, etc., will be increased three-fold.

The cost of postage for the delivery of bills will be increased three-fold.

The general expense in the office for ledger cards, addressograph plates and inter-department stationery will be increased three-fold; and to accomplish the work with the increased force, it will be necessary to install an additional mechanical bookkeeping machine.

We estimate the increased cost of this additional help and equipment as shown in Table I.

Table I

Item	Increased Cost
An Assistant to Contract and New Business Clerk	$ 150.00
Three additional Meter Readers	375.00
Three additional Clerks	220.00
Additional man for shutting off and turning on water	70.00
Stationery—additional bills	30.00
Postage—delivery of bills	120.00
Other stationery	65.00
Maintenance and depreciation of second billing machine	15.00
Increased cost per month	$ 1,045.00
Annual increased cost	$12,540.00

It will be seen, therefore, that to effect a saving of $4,700 per annum to 1½ per cent of our customers, it will be necessary that all of the consumers spend a total of $12,540 per annum. Certainly an inefficient method of saving.

Of course, it will be argued by some, that as the department is earning money in excess of its operating expenses, maintenance, depreciation and sinking fund, and as the property is owned by the public, this additional cost of reading meters monthly should not be considered. We contend that this is a false premise, and that it is the duty of the commission to operate the plant efficiently for all, and that if 98½ per cent of the people are taxed a sum ever so small for the benefit of the 1½ per cent, then some are receiving special consideration.

The department is endeavoring to help all consumers and to this extent reading meters and inspecting premises to aid and assist the consumers in locating their troubles. This service, however, instead of proving beneficial to the consumer, seems to be leading in an opposite direction in that requests for the re-reading of meters and inspection of premises for leaks are increasing, and further, some of the consumers seem to think that it is one of the duties of the water department to locate defective plumbing, and unless the department can locate the cause of the high consumption of water, they take the position that it is the fault of the department and they should be relieved of the excessive bill.

A record of the re-reading of meters during the past four months shows that 10 per cent of the meters regularly read have been re-read on request of the consumer, and in addition thereto, over 400 inspections were made at the request of property holders to determine whether their plumbing was leaking. This reading and inspection service is likely to become an abuse in that property holders do not take the ordinary precaution to watch the services and fixtures themselves.

The plumbing and fixtures of a house are a part of the consumer's property and should be taken care of and watched by him the same as any of the other manifold household operations. If care and prudence are not exercised the fixtures become a "thief in the night," or the same as a careless and wasteful servant.

The meter is a comparatively simple device and as installed is readily accessible and easily read, and an inspection of the meter by the householder will readily determine whether leaks exist. Upon the development of a leak the remedy is to employ a plumber to repair the plumbing and after he has done his work it is a very simple matter to test out the thoroughness of his work by watching the meter for a few moments when no water is being drawn from any of the fixtures.

The matter of leaking fixtures and service pipes are aptly expressed by our mayor in his address to our aldermen as follows: "The duty, therefore, is put up to the individual to watch his fixtures and see that there are no leaks, just as the individual is supposed to do with his health."

In an effort to determine the custom as to meter reading interval, a questionnaire was mailed to 32 cities located in the southeastern portion of the United States and replies were received from 21 including ourselves. Similar information was obtained and tabulated from the annual reports of 12 northern cities.

It was shown from the information received from the southern cities that monthly and quarterly reading of meters are about equally divided, a slight preponderance are at present using monthly readings. Some of the managers who are now reading monthly prefer quarterly reading and some who are now reading quarterly, prefer monthly reading. The northern cities seem to prefer quarterly reading almost unanimously. One city reads semi-annually and bills annually.

We are very much of the opinion that the question of reading meters, as adopted by any community, is more one of custom than otherwise, but where the matter has been gone into with a view of obtaining the most economical operation of the entire system that the reading of meters oftener than quarterly is inefficient and expensive.

In summarizing the arguments for and against monthly reading and billing we have:

Argument in Favor of Monthly Reading.—Possibility of an estimated saving of $4,700 per annum to consumers.

Possibility of catching a leak before the amount of the bill has reached an exorbitant or excessive charge.

The possibility of enabling an individual property holder to check up on the condition of his plumbing.

Argument Against Monthly Reading.—Increased cost to the department of $12,500 per annum.

The above expenditure protects less than 2 per cent of the whole at the expense of all.

Increased number of employes and office force with lowered efficiency.

Increased probability of error, with increased number of requests and complaints from customers for rereading.

Increased complaints as to frequency of bills and requests that bills be sent not oftener than once a quarter, causing confusion in office routine.

Increased complaints of consumers on account of receipt of delinquent notices and the shutting off of water in case of non-payment of bills.

Increase in complaints due to the short period which consumers will have to average up their high or peak consumption. (With quarterly readings, we now have a number of requests that consumers be allowed to make up their excess bills accruing one quarter with deficiencies of the past quarter.)

Will necessitate a revision of our rules and regulations which have been fairly well established and understood during the past five years of operation.

Reduces the credit extended consumers. (At present a consumer has an average credit of approximately 60 days, whereas with monthly reading this would have to be abolished and bills would necessarily have to be paid not later than the 15th of each month.)

Would be a change of custom without a definite assurance of any improvement.

That the quarterly reading of meters and billing for water used has met the requirements of efficient management goes without saying, as is evidenced by the five years of successful operation at Charleston. We passed through the trying time of the world war without an increase in rates for water service when many other water departments throughout the country were forced to raise their rates and issue bonds for increased facilities. We have not only met all of these conditions, but also have brought the plant from a run-down, inefficient condition to a state of high efficiency, making many necessary and permanent improvements, so that today we have a water works system in which every citizen can take pride.

We are not averse to changes if they show a possibility of improvement. We are, however, firm believers in conservatism, especially in the matter of the municipal operation of a water works system, and feel that the public should rely upon the business ability and good judgment of their commission as to the best business policy and the management of the water department.

Construction Increased 25 Per Cent in October

October construction showed a surprising increase, according to F. W. Dodge Corporation. Total contracts awarded during the month in the 36 eastern states amounted to $360,687,000. The increase over September was 25 per cent, whereas the normal season increase is 7 per cent. In 27 of these states the increase over October of last year was 26 per cent.

The large October increase was heaviest in New York state and northern New Jersey, and in the residential class. Apparently the fact that building costs have declined only slightly is not acting as a very strong deterrent on building operations.

Included in last month's record were the following important items: $173,042,000, or 48 per cent of the total, for residential buildings; $63,499,000, or 18 per cent for public works and utilities; $35,133,000, or 10 per cent, for business buildings; $32,721,000, for industrial buildings; and $26,085,000, or 7 per cent, for educational buildings.

The total amount of construction started during the first 10 months of this year has amounted to $2,947,787,000, an increase of 2 per cent over the corresponding period of last year.

Contemplated new work reported in October amounted to $556,491,000, an increase of 43 per cent over the September figure.

Treatment of Industrial Wastes

Methods and Costs at Two Massachusetts Plants Given in Discussion at Engineers' Club of Philadelphia

By HARRISON P. EDDY,
Consulting Engineer, Boston, Mass.

I will describe the procedure which is adopted at two industrial plants in Massachusetts. They are situated on a comparatively small stream lying wholly within the state of Massachusetts. For many years the river has been polluted by industrial wastes. Water is not taken from it for domestic purposes, and at one time it was considered a nuisance, by riparian residents.

About 20 years ago a statute was passed prohibiting the discharge into the river of sewage and of industrial wastes, which tend to create a nuisance. Pursuant to this state plants have been built for the treatment of the wastes at several of the industrial plants.

How a Tannery Handles Its Waste Problem.—In the case of a tannery producing about 500,000 gal. per day of extremely foul wool scouring liquors and tannery wastes, the treatment is regulated according to the condition of the river, which is determined by weekly inspection and chemical tests. These extend over a distance of about 15 miles and are continued from about June 1 to Dec. 1 each year. In the winter and spring when temperatures are low and stream flow is comparatively high, the treatment consists of degreasing the strongest wool scouring liquors and simple sedimentation of the tannery wastes, to remove substances which might settle in the stream. Later, as the flow in the river decreases, measured volumes of water are drawn from a storage reservoir of about 760 million gallons capacity, owned by the tannery, and discharged into the stream. The volume of diluting water is thus proportioned to the volume and composition of the settled wastes and to the needs of the stream. Later in the season the settled wastes are treated with sulphuric acid and sulphate of alumina and allowed to flow through a second series of tanks for further clarification. In other words, they are treated by chemical precipitation to reduce their demand upon the oxygen of the river. With the advent of war summer weather and the usual attendant low stream flow, these chemically treated wastes, after sedimentation, are passed through sand filters. The water is thus purified to a comparatively high degree, so that it is non-putrescible in itself. During this period the volume of diluting water drawn from storage may be reduced, and in some cases dilution in this manner is suspended. During the present year, when the stream flow has been particularly low, this industry, as well as others on this river, introduced into the stream sufficient sodium nitrate to prevent it from becoming objectionable.

In the fall, as the temperature becomes lower and the flow of the river increases, the extent of treatment is reduced; first, the introduction of sodium nitrate is discontinued; second, the chemical treatment is stopped; third, the filters are put out of use. Throughout the winter, however, sedimentation and degreasing are continued, in order to prevent the accumulation in the river of deposits of organic matter which would putrefy and exert a marked demand upon the dissolved oxygen of the river water during the warmer season.

Table I—Cost of Operation and Maintenance (Excluding Fixed Charges) of Tannery Wastes Treatment Plant for 1922

Kind of Treatment	Total Cost	No. of Working Days	Cost Per Working Day	No. of Mil. Gal. Treated	Cost Per Million Gal.
Collection, pumping and sedimentation	$3,571.68	302	$11.38	166.7	$21.43
Chemical treatment	3,444.62	71	48.51	30.3	113.68
Sand filtration	4,989.19	131	38.08	25.2	197.98
Sludge disposal	2,246.85	302	7.44	166.7	13.48
Degreasing plant, net	6,335.30	302	20.97	5.1	1,242.21
Total	$20,587.64	302	$68.17	166.7	$123.50

Treatment of Paper Mill Wastes.—At a paper mill situated on the same stream, the wastes are treated in accordance with their character and the needs of the river, although in this case it is not possible to vary the treatment from season to season to the same extent as in the case of the tannery.

The wastes from the treatment of raw stock with caustic are small in volume and extremely difficult to purify. These wastes are utilized for sprinkling on roads and drives, and when conditions are not suitable for their disposal in this manner, they are spread upon waste land.

The waste from washing the stock treated with caustic are passed through sedimentation tanks and the settled wastes are purified by passing them through sand filters, whence they flow to the river. The solids removed from the wastes, after dewatering in sand beds, are spread upon waste land.

The wastes from the paper machines are treated with chemicals and pumped to tanks, the clarified water being drawn to the river and the prefacture of certain grades of paper.

At this plant water has at times, in dry, warm weather, been drawn from storage for dilution of the wastes, and this year sodium nitrate was introduced into the river, as in the case of the tannery above mentioned. At the paper mill the filters are shut down during the winter.

Cost of Waste Treatments.—It is very important that every advantage be taken of natural conditions and that the treatment of industrial wastes be varied accordingly. This will be evident from an examination of the cost data in Tables I and II. Table I gives the operating and maintenance cost of the tannery wastes treatment plant for the year 1922, not including fixed charges, which are, of course, a substantial item.

It will be seen that the cost of collection, pumping and sedimentation, which are continued throughout the year, is $21.43 per million gallons. The chemical treatment cost $113.68 per million gallons, but it was possible to limit this treatment to 71 days, thus effecting a saving of $48.51 per day for 231 days, over what would have been the cost had this treatment been used throughout the year. A somewhat smaller daily saving results from the limitation of the filtration of the wastes.

Table II gives the cost of operation and maintenance of the paper mill wastes treatment plant in 1916, for which segregated costs are available. The costs given include fixed charges.

Saving is effected also in the case of the paper mill by limiting the filtration of the washer wastes to that portion of the year when the flow of the river is low and the temperature of the water is comparatively high.

In comparison with the cost of treating municipal sewage, which varies roughly from $5 to $15 per million gallons, exclusive of fixed charges, it will be seen that the cost of treating industrial wastes produced by these two plants is exceedingly high—a fact which must be taken into consideration when determining the degree of purification which shall be required of the industries.

In 1922 the total cost at the tannery was about $32,400, and at the paper mill about $44,700, including fixed charges in both cases.

Table II—Cost of Operation and Maintenance (Including Fixed Charges) of Paper Mill Wastes Treatment Plant for 1916

Kind of Treatment	Total Cost	No. of Working Days	Cost Per Working Day	No. of Mil. Gal. Treated	Cost Per Million Gal.
Boiler wastes	$833.00	300	$2.75+	1.35+	$600+
Machine wastes	26,711.01	300	89.04	1137	23.49
Washer wastes:					
Sedimentation	1,143.57	300	3.81	98.5	11.61
Sludge disposal	2,400.53	300	8.00	98.5	24.13
Sand filtration	2,832.63	177	16.00	19.8	143.06
Total	6,376.73	300	21.25	98.5	64.73
Total	$33,920.74	300	$113.06	1237	$27.42

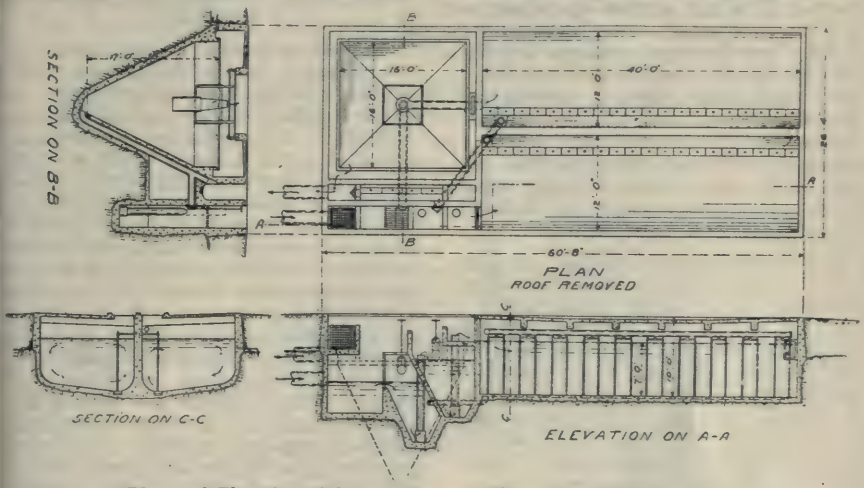
Small, Compact Activated Sludge Plant

An activated sludge plant differing somewhat from the usual design was placed in operation this spring by Crystal Beach, Ont., a small village on the north shore of Lake Erie, about five miles west of Fort Erie. The village has about 300 permanent residents, although there are within the limits of the corporation 1,000 cottages, with probably as many more in the neighborhood. The summer population for the whole district is from 8,000 to 10,000. We are indebted to The Canadian Engineer for the following details of the sewage disposal plant:

The volume of sewage to be taken care of in this installation is very small at present and it will only increase as sewers are laid and water works installed in the various summer cottages. When the maximum development is reached, the plant will only need to be in operation about three months in the year, so it was essential that the plant be designed as simple and as inexpensive as possible. The object in view was to provide adequate equipment for the time being, leaving ample room for any future increase that might be found desirable to make. The unit as designed will, with these reservations, be complete in itself, but provision is made for an additional unit should one be required in the future.

The design is based on the experimental data collected by the Provincial Board of Health, and which was made available to the designer by the courtesy of F. A. Dallyn, provincial sanitary engineer.

The plant consists of the usual features. The sewage enters the grit chamber, and passing through a 3 in. screen, is raised in two steps by air lifts and is discharged into the aerating tanks through a 1 in. screen. The aerating tanks are in duplicate, the sewage passing the length of one and back through the other to the settling chamber. The settling chamber is conical in shape and is equipped with a "Clifford" inlet to prevent the formation of eddies by the inflowing sewage.



Plan and Elevation of Sewage Disposal Plant, Crystal Beach, Ont.

The settled effluent is taken off around the top of the chamber by an overflow weir and is collected in a channel and passes back to the drain below a flap gate. The sludge in the settling chamber is taken off by means of an 8 in. pipe to the sludge tank, where it may be re-aerated before a portion of it returning to the raw sewage. Excess sludge is run into a large sludge chamber. For the reasons explained above, it was not considered advisable to make any elaborate provision for treating this sludge at the present time, but when the quantity to be handled warrants installation of proper equipment it can then be installed. The amount of sludge returning to the raw sewage is regulated by means of an adjustable weir. By setting this for an

average rate of flow through the plant any variation from the average will affect the volume of flow over this weir, and thus the plant will be self-regulating within certain limtis. The whole process is laid out so as to act entirely by gravity and the only mechanical equipment required is an air compressor to provide air for the air lifts to raise the raw sewage and for the aerating tanks.

It will be noted that the aerating tanks are built on a somewhat different principle from that on which recent activated sludge plants have been constructed in Ontario. These tanks, instead of being narrow and deep are shallow and broad. In a tank of this shape, the sewage presents a large surface to the atmosphere and it has been found that such a surface will absorb oxygen from the air and thus reduce the amount of air which is necessary to force through the sewage. This shaped tank was also much more economical to construct and better adapted for this location.

The mechanical equipment consists of a single Nash Hytor air compressor, No. 2, direct connected to a 10 h. p. motor. This compressor has a capacity of 200 cu. ft. of free air per minute, against 4 lb. pressure, which will be sufficient for the present to feed the aerating tanks and operate the air lifts. Provision was made for installing another compressor at some future time when necessary.

All the air piping and the diffuser plates and "Clifford" inlet were supplied by Activated Sludge, Ltd., of London, England, the patentees of the process. The diffuser plates are made of porous concrete set in cast iron frames and are made in sections 12 in. wide by 2 ft. long. Each section is supplied with air through separate connections, provided with a special needle valve for accurate adjustment.

The plant is set with the roof level with the ground with the exception of a small house to shelter the blower. The roof of the plant is provided with movable covers so as to give access to every part for inspection or adjustment. All drain-off valves, bypasses and so forth, necessary for the operating of the plant are provided.

The construction of the sewer and the disposal plant was carried out by F. F. Fry, who was the general contractor for the whole work, under the superintendency of G. W. Sharp, and was completed without accident and without any addition of extras, at the contract price. The cost of the sewer was $53,000, and the disposal plant cost complete about $12,000.

All surveys and field work was carried out by J. R. Scott of Ross & Scott, Welland, Ont., and H. R. Dillon acted as inspector and resident engineer throughout the work. E. H. Darling had complete charge of the design and construction as consulting engineer for the municipality.

Work of U. S. Geological Survey in Past Year

According to the annual report of the director of the fiscal year 1923, the work of the Geological Survey has covered effectively the broad field assigned to that organization, embracing geologic and topographic surveys, the study of mineral deposits, the collection of statistics of mineral production, the measurement of the flow of streams to determine the quantities of water available for use and to provide information needed for projects designed to prevent floods, the study of available ground water, and the classification of the public lands preliminary to the issue of patents or leases. More than 40 per cent of the United States has now been accurately mapped topographically, a large knowledge of its geologic features and mineral resources has been gained, and widely extended studies have been made to discover geologic processes, especially those that determine the accumulation of mineral deposits. Work has been continued in Alaska, surveys having been carried along the Alaska Railroad and elsewhere, surveys of oil fields having been made, and the condition of the mining industry in the territory determined. The work of the Geological Survey has in the past been largely instrumental in promoting development in Alaska and it is now hoped that, partly as a result of the completion of the Alaska Railroad and the survey of mineral lands, the territory may be able to enter upon a new period of prosperity. During the year the survey distributed nearly a million and a quarter publications, of which nearly 600,000 were sold, and performed about $100,000 worth of lithographic work for other branches of the government.

Problems of the City Manager in a Community of About 10,000

By FRANK D. DANIELSON,
Village Manager, Hinsdale, Ill.

The problem of a city manager in administering to an institution like a municipality with its responsibility for service entering into all of the various activities of its citizens, domestically and commercially, to work effectively, must be actuated by a continuous policy or motive and must make every line of action conform to a program directed towards carrying through that policy. Changes in time and conditions may affect the program but the underlying policy must be constant.

The sole function of a municipal organization is to render service. Dividends cannot and are not paid as by a private corporation, at the end of a fiscal year; instead of measuring the earnings in dollars, the return to citizens or stockholders of the incorporation are measured in services which are given every day of the year in one form or the other. It may come through the administration of public works, health and welfare, or the direction of public safety. Whatever it is or where it may come, its policy must be to subordinate all other considerations to giving a satisfactory service. Service to be satisfactory must be of the scope and quality desired, and it must be worth all and more than it costs.

A great many cities and towns in the last ten years have entered a period of reconstruction, and many of the plans and methods which have proved successful have a direct application in the every day practice of the city manager. The short comings of the federal and the commission type of government paved the way for the commission-manager form, which stands first as the exponent of business efficiency to render the service for which it is intended.

The Big City and the Town of 10,000 Compared.—In theory, the problems of the city manager in a community of 10,000 population are the same as in a large city, but in practice they are quite different. Sound business management involves much more than economy of expenditures; it must have above all things a plan which the manager is in position to carry out.

In the community of 10,000 or less, the place of the city manager is difficult because he is confronted with a multitude of details in all departments, besides being required to have contact with the major problems which lead to a definite program. The manager is often the only well trained person in a municipal organization, and because of the detail duties he has to take care of, is at all times overcrowded with work. In a large municipality, department heads are responsible for all details and the manager is more able to direct his efforts along lines which lead to a constant policy.

By comparing the ratio of engineering expenditures to the sum total expenditures of a large city with one having a population of 10,000 or less, it is interesting to note differences depending on the magnitude of the city's municipal affairs. In Chicago about 21 per cent of the total municipal expenditures are strictly engineering, about 67 per cent are non-engineering, and about 12 per cent are composed of engineering with other included expenses. These percentages have been computed from the data of expenditures as compiled in "Report of the Comptroller of the City of Chicago." In the average city like Dayton, O., the strictly engineering expenses are about 41 per cent. Mixed engineering amounts to 5 per cent, and the non-engineering reaches close to 54 per cent. The "Comparative Expense Statement of Dayton, O.," which is published annually by the commission of the city, furnished the source for computing these percentages. If the financial reports of cities and towns of 10,000 population or less be studied, the conclusion would be that a higher percentage of the expenditures are strictly engineering. In other words, engineering percentages are larger in the small towns than in a city. The manager of a large city is involved the greater part of the time in satisfying public sentiment or opinion. In the small town the city manager's duty is to reduce the expenses in all departments to a minimum, besides being called on to satisfy public opinion.

If the administering of utilities is also required, a fact which is most common in a small town, the demands upon a city manager are usually at the breaking point of his endurance. In all of these lines of action, foresight, based upon studies of the facts of the past and present and intelligent estimates of the future has to be the basis to a program directed toward carrying through the policy before mentioned.

Managerial Duties in a Small Community.—In viewing the problems of a city manager in a town of 10,000 at close range we find that he must be an expert in public health, economics of health, disease prevention, sanitary inspection and food control; all of which are cared for in the larger city by a full time doctor or health commissioner. In welfare work, the city manager in a small town is often called on to select suitable sites for parks and playgrounds, to supervise and manager the same, to administer to charities and offer treatment of minor criminals. In the administration of public safety, the city manager in a community of 10,000 will be called on to take all responsibility connected with the organization, recruiting, training and disciplining the police, as well as being a master of crime prevention. In problems of fire prevention, there is, besides overhead administration, the care of equipment, training and discipline and education of the public. To properly administer public works, which the city manager must do in the small place, a thorough knowledge of city planning is absolutely essential. He must be equally familiar with zoning and building restrictions, building codes, and aims to be accomplished. Problems relating to the distribution and type of public improvements, the supply of water, filtration and softening and underground system of same; the conditions of governing a sewer system with construction and maintenance; refuse disposal, collection, separating waste and their distruction by incineration, reduction or otherwise; streets, their paving and effect thereon of traffic, maintenance and cleaning.

Besides the above, which is along the line of public works, safety, health and welfare, the city manager must understand municipal jurisdiction, constitution and powers of municipal corporations, rights, duties and liabilities of public officers. In the realm of finance, he must have intimate acquaintance with public accounting and financial reporting, purchasing, sources of revenue and appropriation, accounting, budgets and budget making, together with legislative consideration and action on same, and lastly, special assessment procedure, general taxation and sinking funds.

Then, besides all this, problems of public employment and methods of improving the personnel, standardization of salaries, local transportation and publicity, or letting the people know how their community is being operated, must be solved by the city manager.

In other words, the city manager of a town of 10,000 is called upon to perfom the functions of a health commissioner, lawyer, engineer, business man and social worker.

After accepting the position and taking office, the manager of a new commission-manager community will find himself face to face with the problems of re-organizing all the departments. After re-organization, the installation of system begins. After the system is installed and running smoothly, the real work begins. The operating methods of the various departments must be studied and means devised to stop the waste and leaks. After these problems have been worked out, the manager finds he has only begun; he is confronted with further problems, as: zoning, city planning, new sub-divisions, perhaps annexations, water filtration and softening plants, booster mains for the water distribution system, adequate water supply and storage, electric light and power, manufacture and delivery of ice, new municipal building, including a fire and police station, elimination of dangerous street intersections, street and ornamental lighting installation, parks and recreation fields, police and fire alarm systems, railroad grade separations, and numerous other problems that are forever coming up in a modern and growing municipality. Then, too, the activities surrounding a well managed community are very important and must be studied and watched in order to form a proper relationship. However, above everything else, the city manager in a community of 10,000 must formulate a constant policy which will give a service as has been described, broad in scope, good in quality, and in every way satisfactory to the public.

Iron Removal From Naval Academy Water Supply

Deferrization Plant and Its Operation at Annapolis, Md., Described in Public Works of the Navy

By EDWARD C. SHERMAN,
Project Manager, U. S. Bureau of Yards and Docks

The water supply for the Naval Academy is secured from wells drilled through the upper strata to a bed of gravel which overlies impervious rock at a depth of about 600 ft. Six wells have been put down, but only the three latest ones are still in use. Wells Nos. 1 and 2 have been out of commission for a number of years, and well No. 3 failed abruptly in 1917 after being in constant use for about eight years, during which time its yield gradually decreased.

The amounts of water that can be secured from the wells still in use, Nos. 4, 5 and 6, are approximately 600,000, 1,100,000 and 640,000 gal. per day, respectively.

With some 2,400 midshipmen at the academy, it was assumed that the legitimate requirements should not exceed 500,000 gal. per day, and when, late in 1920, it was found that the water consumption had reached 820,000 gal. per day a water-waste survey was started. Although it was not completed, it resulted in a tremendous saving of water, as a leak in the mains, through which about 200,000 gal. were flowing daily, was located and stopped.

Presence of Iron Cause of Water Waste.—A part of the excessive draft on the supply was due to the presence of iron in the water, which caused users to waste large quantities in the effort to secure a clear stream. The iron is in solution in the ground water as ferrous hydrate, but is oxidized to insoluble ferric hydrate by the air with which it comes in contact when being raised by an air lift.

Before proceeding with plans for improving the existing supply, sufficient consideration was given to other possible sources to indicate the desirability of the course adopted. A surface water supply could be secured about 11 miles northwest of the academy, but the water is somewhat hard and, besides, would require filtration and chlorination to make it safe. A rough estimate of the operating cost, including interest on the cost of necessary plant, showed that it would approximate $50,000 a year, while the cost of operating a deferrization plant, including interest charges, was estimated at only $11,000 a year.

The well-water supply is free from bacteria, and, though somewhat hard and containing over 20 parts per million of iron, it seemed highly advisable to retain it and make it of satisfactory quality by appropriate treatment.

Determining Treatment Necessary.—Analyses of the water indicated that the iron could be removed and the water softened by aeration and treatment with lime and soda ash, followed by sedimentation and filtration. The cost of softening the entire supply was not believed to be justifiable, in view of the relatively small part used in the power plant and the laundry. Moreover, the appropriation available limited the amount of work that could be done.

To determine the treatment necessary to remove the iron, the Naval Academy made a number of tests, applying various doses of lime to the water, both with such limited aeration as is given by the air lifts and with additional aeration. It was found that the additional aeration hindered precipitation of the iron, the best results being secured by an application to the water as pumped from the wells of approximately five grains of lime per gallon, and that precipitation was completed in about 4½ hours.

It appeared, therefore, that it would be necessary only to provide suitable apparatus for applying the correct dose of lime, together with an adequate sedimentation basin to eliminate all trouble with iron. As is was found that a section of the existing underground storage reservoir could be spared without affecting the continuity of the supply of water, this section was adapted to the needs of a sedimentation basin by constructing in its suitable baffle walls and providing connections for inlets, outlets and drainage.

Design of Plant.—The general scheme of operation of the deferrization plant is shown by the diagram and is as follows:

Water is raised from the wells by air lift and led to a dosing chamber in the new filter house, where lime solution is applied by automatic apparatus at a rate proportional to the flow of water. The treated water then flows into the settling basin and traverses its length twice, being directed in its course by a light partition wall so located that the velocity gradually decreases from inlet to outlet. At the outlet end of the basin the water passes over a weir into a trough and through a pipe to the clarifying filters, when it flows into the storage reservoir, from which it is pumped into the mains.

The Dosing Apparatus.—The apparatus for automatically applying the correct amount of lime at whatever rate water may be coming from the wells is sufficiently interesting to be worthy of detailed description. It consists, in general, of a weir box, a dividing box, a tipping meter, lime mixing and solution tanks wth motor-driven agitators, and a lift pipe actuated by the tipping meter.

In operation the raw water to be treated flows through the weir box and is kept at a constant level by means of a float valve. The weir box has two outlet openings, a large one for the treated water and a small one for the flow to the dividing box. Both being under the same head, the smaller flow is always exactly proportional to the larger one.

The dividing box has a manually adjustable orifice, which wastes a certain amount of the water, while the remainder passes to the tipping meter. The orifice control permits instantaneous adjustment of the chemical feed at the w[illegible] munic[illegible] operator.

The tipping meter i[illegible] and liabili[illegible] the realm y the water reaching it from the dividing box, so that its oscillations are in exact proportion to the flow of water through the plant and at a rate commensurate with the desired rate of feeding the lime. The oscillations actuate a drum and unwind the cable which lowers the lift pipe in the chemical-solution tank. The rate of lowering the lift pipe is consequently proportional to the rate of flow through the plant, and as the lift pipe is constantly skimming off the surface of the milk of lime, which is kept at a uniform strength by means of the agitator mechanism, the amount of lime applied to the raw water is also invariably proportional to its rate of flow.

The reservoir compartments, which are used as sedimentation basins, are larger than are necessary to provide the period of 4½ hours for precipitation, which experiments indicated would be required. It was not considered advisable to omit filters, however, as a larger consumption of water, reduction of basin capacity due to accumulation of sediment, or unequal distribution of flow in the basins might cause the water to pass through in less time than was assumed, with resultant carrying over of precipitate into the mains.

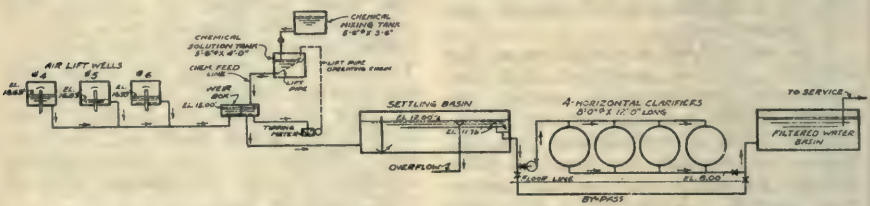


Diagram of Successive Stages of Operation of Deferrization Plant at Naval Academy.

Result of Deferrization.—The wisdom of providing filters is shown by the results of recent analyses of the water, which gave results as follows:

Iron in parts per million:	
At weir box	20
Before filtering	1.8
After filtering	.2

The effect of deferrization appeared in an immediate reduction in use of water. Although in 1920 stopping a leak had reduced it to 620,000 gal. per day, the consumption had increased, and just before putting the plant in operation the academy was using about 850,000 gal. per day, which was reduced to about 600,000 gal. per day immediately thereafter.

Methods for Detecting Underground Leakage

Extract From Committee Report Presented at 1923 Convention of American Water Works Association

Pitometer Surveys.—The most generally used method to locate subsurface leakage is to measure the flow through the mains by tapping the main with a 1-in. cock, and inserting a pitometer, using a portable continuous recording device for the period of time desired. It is usually advisable to place a permanent manhole over the tap so that it may be readily used for subsequent surveys. The area to be surveyed is divided into a convenient number of districts, so arranged that, if possible, one instrument may measure the flow into the district. The district is formed by closing gates on the boundary, and care must be exercised to provide sufficient water to meet a sudden demand caused by a fire in the district. After the district is formed and the normal flow measured, the district is reduced by cutting off one or more blocks at a time, doing this work at night when the demand is at a minimum. The record of the pitometer will show how much reduction in flow is caused by each section of main shut off. Those sections which indicate a suspiciously high flow are further investigated, by pitometer or aquaphones, and the cause of the high flow ascertained. Usually it is found that one or more leaks exist on the main or services under suspicion. This method is one that must be carried out by men skilled in the use of these instruments if it is to be successful. The system is practically the same as that followed when the Deacon meter was used. Boston, Mass., used that system extensively some 40 years ago, but today the pitometer takes the place of the Deacon meter.

Hose and Meter Surveys.—To determine the flow in one or more blocks a meter, usually of the 2-in. disc or current type, may be connected by hose lines to two hydrants, and the mains to be tested supplied by opening the two hydrants and closing valves, so that all the flow must pass through the meter. By mounting the meter on a light auto truck additional facility of measurement is afforded. This system requires many more measurements to be taken than the pitometer system, and is not so generally used, but the principle is virtually the same. In small systems, where comparatively few tests are required to cover the distribution system, the hose and meter test may be advantageous over the pitometer method, but ordinarily the pitometer is to be preferred due to the more rapid progress made, the establishment of permanent points of measurements, and elimination of interference with the flow through the main pipe feeding the district.

Aquaphone Surveys.—The aquaphone is one of the most valuable of the devices available to aid in locating hidden leaks. It cannot tell you whether leakage does or does not exist on a given long section of main or what is the rate of flow through the mains, but it can reduce greatly the cost of locating leaks after it is known that one or more leaks are on a certain section of main, on services or on other connections. If the superintendent will regularly use an aquaphone on valves, hydrants, services at point of entry into buildings, and at curb docks, he may locate and correct at a minimum of expense all sub-surface leakage other than that on the mains and blowoff or similar connections and may frequently locate even these latter leaks. By combining the tests of flow in mains with aquaphone tests, all leaks that are of sufficient size to justify their stoppage may be located and eliminated. Small diameter rods driven down to the main greatly aid in locating leaks and avoid disturbances of pavement. The superintendent must judge for himself when he has reached the economic limit of search for underground leaks, by comparing the cost of locating the leaks with the value of the water saved by stopping the leaks. The time interval before making a reinspection by aquaphone must also be determined for each community and for each group or class of pipe and appurtenances. In general, it may be considered good practice to test hydrants once a year, house services once a year, more or less depending upon whether the inspectors visit the premises for other purposes, and the mains about every two years.

In Buffalo, where the pitometer system is used, with the aquaphone as an aid, and house to house inspection for building leakage, the entire system was covered in three years. With a permanent pitometer force of four men the city is resurveyed at an interval of from one to two years.

Subsurface Leak Detection in New York City.—In New York the force available for underground leak detection work has never been sufficient fully to cover the locations where it is known leaks exist. The aquaphone is therefore generally used with rods driven to the main furnishing the most helpful means of securing the necessary sound for location of leaks. The force employed since the latter part of 1919 has been three assistant engineers, four engineering assistants, sixteen skilled and unskilled laborers. The labor force has been divided into four gangs each with its 1½-ton auto truck. Prior to 1919 the labor force was about one-half the present force. During 1922 the estimated cost for salaries, wages and supplies was $49,144 and 291 leaks averaging 62,155 gal. per day were stopped. On the assumption that the leaks found and stopped would have remained unchecked for two years, if the special force had not been assigned to this work, the estimated cost of water saved is $3.62 per million gal.

The following table is a record of this work since it was commenced in 1910:

Year	Description	Leaks Located and Repaired	Stopped M.G.D.	Cost per M.G. Saved
1910	River crossings	2	4.00	
1911	Manhattan Waterfront	17	3.50	
1912	General waste surveys	33	3.80	
1913	General waste surveys	56	5.40	$3.55
1914	General waste surveys	64	11.00	3.24*
1915	General waste surveys	106	7.20	2.52
1916	General waste surveys	149	12.25	1.34
1917	General waste surveys	158	11.35	1.15
1918	General waste surveys and investigations of reported leakage	150	11.26	2.08
1919	General waste surveys and investigations of reported leakage	173	9.35	3.18
1920	General waste surveys and investigations of reported leakage	305	19.77	2.79
1921	General waste surveys and investigations of reported leakage	312	16.27	3.83
1922	General waste surveys and investigations of reported leakage	291	18.09	3.62

*Two large leaks totaling 5.5 m.g.d. excluded in computing cost.

$$\text{Cost equals } \frac{\text{total cost of work}}{\text{m.g.d. saved} \times 365 \times 2}.$$

With the trained men the number of street openings per leak averages only about one and one-quarter, although leaks are found a block or more from where there is visible evidence of the leak in a cellar or other low spot, and some of the leaks found are known to have existed for nine or more years.

Apprentice Training Principles

At a conference of representatives of national organizations of building trades employers and employes and manufacturers of building materials, held Nov. 15 under the auspices of the Federal Board of Vocational Education, the following principles were agreed upon as essential to a successful apprentice training program:

That a local representative committee, composed of all interests in the industry, is essential.

That part-time or evening schools be provided to supplement job training.

That "all-around" training is more desirable than specialized training.

That national association should set up fundamental training standards for apprentice training, and make information available for instructional purposes.

That co-operation with the public schools is essential.

That incentives should be set up to induce boys to enter upon apprenticeship.

That pre-employment training for employed apprentices or boys under contract is recommended.

Testing the Boiler in the Small Plant

Practical Suggestions of Interest to Water Works Men Given in Power

By A. R. KNAPP

A boiler test for evaporation is such a simple procedure that the practice of periodical testing of boilers for evaporation and efficiency should be more generally adopted by men in charge of isolated plants. The evaporation test is valuable in that from its results the boiler efficiency and the cost of steam can be computed. At best a boiler is an inefficient piece of equipment, and any effort expended to raise this efficiency is time and energy well spent.

Knowing definitely what the boilers are doing should be a part of every engineer's duties, and in order to figure the cost of isolated plant power, this factor must generally be known. In plants equipped with water meters, recording thermometers and coal-weighing equipment the process is somewhat simplified, but the small plant without these refinements can obtain satisfactory results.

To run an evaporation and efficiency test, the following items must be known: Total weight of coal burned during the test, total weight of water evaporated during test, average temperature of feed water, average steam pressure, and the heat value in B.t.u. of the coal used. The test should be run for a period of not less than eight hours. A longer test will give more accurate results.

Method of Weighing the Coal.—In the absence of coal-weighing equipment, the best method of weighing the coal is to use a platform scale and weigh each wheelbarrow load. To weigh the feed water, the simple method of using two barrels, one elevated above the other, may be used. The feed water is piped to the upper barrel and is dischargd into the lower one through a valve placed in the bottom of the barrel. The lower barrel connects to the suction of the feed pump. It is advisable to have a bypass to the feed pump from the regular water supply in case something goes wrong with the barrel arrangement. Weigh the upper barrel when empty, then fill with water and weigh again. In this way the weight of water used during the test may be determined by multiplying the weight of water in the barrel by the number of times the barrel is filled.

In order to start the test, make a note of the condition of the fire, so that it may be left in the same condition when the test ends. If the boiler was fired five minutes before the test started, see that it is fired five minutes before the test ends. It is only in this way that the same condition will exist at the start and finish, and the coal weighed will be the same as the coal consumed.

Note the level of the water in the gage glass and mark this level with chalk or cord. When the test is nearing completion, see that the water is at this mark. If there is no thermometer in the feed-water line, suspend one in the upper barrel of water. The feed-water temperature and the pressure on the boiler should be read every half hour. If either of these fluctuates considerably, it is better to take readings every 15 minutes. At the end of the test add the readings and divide the sums by the number of readings; in that way the average temperature of feed water and steam pressure will be obtained.

How the Evaporation Test Is Figured.—In order to show how the evaporation test is figured from the results obtained, the following case is worked out:

The weight of coal burned, 4,400 lb.; total weight of water evaporated, 32,000 lb.; average temperature of feed water, 184° F.; average steam pressure, 110 lb.; length of test, 8 hours. From the results obtained it is found that 4,400 lb. of coal were used and 32,000 lb. of water evaporated. Hence $32{,}000 \div 4{,}400 = 7.2$ lb. of water evaporated per pound of coal burned. This 7.2 lb. is the "actual evaporation." The "equivalent evaporation from and at 212° F." must now be calculated.

It is a well known fact that it takes more coal, and therefore more heat, to make steam with cold water than with hot water, also that it is easier to make steam at a low pressure than at a high pressure. Therefore it is obvious that the heat required to evaporate 7.2 lb. of water into steam will depend on two things; the temperature of the feed water, and the pressure of the steam in the boiler.

In order to change a pound of water

at 212° into steam at 212° F. at zero gage pressure, there must be added to it 970.4 B.t.u., which is called the latent heat of steam at atmospheric pressure. In the example given, the feed water temperature was 184° F. and the steam pressure 110 lb. gage. The amount of heat required to change a pound of water at 184° into steam at 110 lb. gage is not the same as that required to make a pound of steam from and at 212°. Therefore the actual evaporation must be multiplied by a "factor of evaporation."

The factor of evaporation for the temperature and pressure given is found from any table of factors of evaporation to be 1.07. The factor 1.07 indicates that to change a pound of water at 184° into steam at 110 lb. pressure requires 1.07 times as much heat as to change a pound of water at 212° F. into steam at atmospheric pressure. Hence, $7.2 \times 1.07 = 7.7$ lb., equivalent evaporation from and at 212° F.

As it takes 970.4 B.t.u. to make a pound of steam from and at 212°, to make 7.7 lb. will require $7.7 \times 970.4 \div 7{,}472$ B.t.u.

Expressing Efficiency of Boiler.—The efficiency of the boiler may be expressed as a ratio of the output to the input. By output is meant the quantity of water exaperated per pound of coal fired. Input is the amount of heat contained in a pound of the coal as fired. It is preferable to have a test made to determine the heating value of the coal used during the test. If this cannot be done, then learn the grade of coal and the district from which it came. Many handbooks on engineering contain a table giving the heating value of various grades of coal used for steam power purposes.

In the case worked out in the foregoing it is assumed that the coal has a heating value of 13,000 B.t.u. per pound. For every pound of coal fired, 13,000 heat units are liberated, and this value is taken as the input. The efficiency of the boiler may then be calculated as follows:

$$\text{Efficiency} = \frac{\text{output}}{\text{input}} \text{ or } \frac{7{,}472}{13{,}000} = 0.574,$$

or 57.4 per cent.

Knowing what the boiler will do from the results obtained, it is a simple matter to figure the rating at which the boiler was operated during the test. The normal rating of a boiler is given as 3.45 lb. of water per square foot of heating surface per hour from and at 212° F. Therefore the boiler rating developed, per cent, equals equivalent evaporation per square foot divided by 3.45 and multiplied by 100. Or, taking the figures given in the test, the factor of evaporation was found to be 1.07. Now, dividing 3.45 by 1.07 we get 3.22, which is the rated evaporation per square foot per hour instead of 3.45 as under the standard condition. Now say the boiler had 1,000 sq. ft. of heating surface, the evaporation at normal rating would be $1{,}000 \times 3.22 = 3{,}220$ lb. Since the boiler evaporated $\frac{32{,}000}{8} = 4{,}000$ lb. of water per hour the rating would be $4{,}000 \div 3{,}220 = 1.24 \times 100 = 124$ per cent, or 24 per cent above normal rating.

Deepening Rivers With Explosives

Accumulations of mud and silt, which are very often troublesome in the beds of rivers and in tidal estuaries, can often be economically and expeditiously removed by the use of explosives, according to Water and Water Engineering, London. The principle adopted is to disturb the accumulated material by exploding a series of charges simultaneously when the water over the silt is at its maximum flow, and so allow the current to carry away the displaced material. This procedure is repeated as often as is necessary until the whole bed has been cleared away. Holes of about 4 to 5 ft. deep are usually placed about 6 ft. apart, and the amount of charge in each hole may be anything from ½ to 1 lb., according to circumstances. If the loading has to be done under water each charge is contained in a waterproof bag and fastened to the end of a stick, by means of which it is pushed into the prepared hole as soon as this has been bored. The stick is allowed to remain in position, holding the ends of the detonator wires above water to permit them to be properly connected. All the joints must be thoroughly insulated, and submarine electric detonators used. Blasting gelatine, gelatine dynamite or gelignite is suitable for work of this description.

Railways

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co.
221 East 20th St., Chicago

HALBERT P. GILLETTE, *President and Editor*
LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 904 Longacre Bldg., 42d St. and Broadway
RICHARD E. BROWN, *Eastern Manager*

The specialized publishing plan of Engineering and Contracting provides four rotating monthly magazines, each of which is $1 a year. All four may be subscribed for at $4 a year, and thus taken they provide a weekly service completely covering the construction field.

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Vol. LX. CHICAGO, ILL., DECEMBER 19, 1923 No. 6

Canals, Railways and Highways

Whatever our doubts of yesterday we know today that the self-propelled vehicle on the public highway is a factor in commodity transportation; and so far as we can forsee it is a permanent factor. For the short distance hauling of many classes of goods it has established its place, and the effort is being made to extend as far as possible its field of operations. Undoubtedly, with the construction of more and better roads, continued improvements in the trucks themselves and changes in our all too durable habits, the truck will take still more of the local freight business from the rails. That it is likely to be a real competitor for long haul freight traffic the editor does not believe.

The total cost of moving a given consignment from one point to another is made up of many sub-costs, and the most economic method of moving that consignment is the method for which the total cost is a minimum. In addition to the cost of the main haul, the sub-costs include all terminal hauls, as from railroad freight station to final destination; all costs of loading, unloading or other handling; insurance against damage; interest on the cost of the consignment in case the time is long, or more often a charge based upon the value of time in connection with the consignment, although not interest in the ordinary sense. As yet the economic limits of rail and truck transportation have not generally been determined. There is a short haul field in which the truck affords unquestioned economy, and a long haul field where it is quite unable to compete with the rail lines; but between the two is an area where supremacy is undecided. Relative economy by the two methods is not governed solely by distance. Local conditions affect it materially, and hence it must be determined independently in every case. But it is obvious that either one method or the other will be the more economical in all but exceptional instances, and the railroads may as well reconcile themselves to the surrender of some of their once profitable business.

We may look for a fairly rapid defining of the now hazy economic limits, although there will always be shiftings of such limits as conditions change. One of the changes to be reckoned with is the levying upon the trucks of a proper charge for their use of the highways. It is neither desirable, nor likely that the highways will be withdrawn from the use of common carriers, although this suggestion is still sometimes made; but it seems equally clear that the highway users should and will be made to pay reasonably for their use. Whether this should be done through a gasoline tax or otherwise need not be discussed here. The effect will be to narrow the field of trucking operations—not as a recognition of a vested right of the railroads nor as an expedient concession to them, but as a measure of fairness which will react to the economic benefit of the community as a whole. Thus there will be a restriction on the expansion of the trucking business which otherwise would occur.

What the railways are likely to lose to auto trucks is far less than what the canals and old post roads lost to the railways. With the coming of the steam roads the post road, as such, ceased to exist. The canals and rivers suffered a slower eclipse, but in the end they too succumbed. Many were completely abandoned; others, like the Erie, kept a feeble hold on existence; but as a major means of transportation, the inland waterways were destroyed. Now they are showing signs of a returning vitality, which is as it should be. We do not mean that all should be revived. The millions squandered on waterways through pork barrel politics are for the most part gone irretrievably. But there are also good rivers and good canals and good canal projects; and insofar as freight can be handled by these more economically than by rail, it should be so handled.

Presumably had the canal and river operators been better organized, and their business better administered, the extent of their loss would have been greatly reduced. Still more, had the waterways been operated in conjunction instead of in competition with the railways they might have served a permanently useful purpose; for admitting all the advantages of speed and convenience furnished by the rails, there remained large quantities of goods which could be handled cheaper by water. Especially was this so in view of the fact that the waterways were already built and in operation. While in many instances it would not have paid to build a canal to compete with the railway, a canal already built could be maintained and operated at a cost which would enable it to underbid the railroads on certain classes of freight.

In the present business era with its host of able executives in every field, its habits of careful economic analysis and its finer drawn competitions, it is natural that attention should again be given to inland water transportation as means for money saving or money making. Goods of small value per unit of bulk or weight; goods produced seasonally, like the grains, but consumed continuously; and other goods for which slower delivery is permissible would compose the water borne freight. There will be difficult problems and heavy costs for terminals and other features, but we are used to problems and expense, and can count upon their being adequately met.

The desideratum is a transportation machine of maximum efficiency—a machine in which canal, railway and highway each performs the functions to which it is best adapted. Obviously the most direct means to this end is through a combination of transportation facilities under one management; and it would seem that the railways with their wider scope, their established terminal and other facilities, their strong organizations and able administrations, should be the ones to undertake and direct the consolidation.

Employees of Great Northern Ry. Can Become Stockholders on Partial Payment Plan.—Employees of the Great Northern Ry. can now purchase stock of that company on a partial payment plan. Each contract is limited to 25 shares, but may be repeated as often as desired. The stock may be purchased with an initial payment of $5 a share followed by monthly installments as small as $3 a share until payment is completed. Installments may be paid by monthly deductions from the employees' pay and the account will be carried at 6 per cent interest.

Rail Failures in Great Britain and America

Editorial in Railway Engineering and Maintenance

On the railways of Great Britain, comprising more than 25,000 miles of line, less than 200 rail failures occur annually or an average of less than four per week. In contrast with this, statistics compiled by the American Railway Engineering Association show an annual rate of failures in the United States and Canada of approximately 20 per 100 miles of track or more than 25 times as many as in England. It is true, of course, that the wheel loads in that country are much lighter than those in America, but the speeds are as great or greater and the density of traffic much greater and the weight of rails is less than in this country. More important, however, are the facts that the tracks in that country are maintained to higher standards than prevail here and also that more care is taken in the production of the rails there than here. This contrast places railway maintenance men and steel manufacturers in America in an unfavorable light which they should hasten to rectify by perfecting those methods which contribute to our present unsatisfactory record.

Engineering Qualifications

Editorial in Power

Personal qualities that make for the best all-around engineers have been much discussed by both educators and employers. While such discussions have led to more or less tangible results, the subject still remains largely a matter of opinion. It is therefore illuminating to note what the Westinghouse Electric and Manufacturing Company has to say as a result of several years' experience with the engineering scholarships which it awards annually.

To begin with, only those young men who have shown aptitude for physics, chemistry and mathematics in their preparatory schools are considered. The selection is narrowed further to intelligence, physical qualities and ability to shoulder responsibility. Mental alertness is given greater weight than acquired knowledge, for it is considered that this characteristic is a measure of one's ability to grasp quickly and accurately a new point and retain it. Physical activity is generally accompanied by mental activity and conversely, the sluggish mind is usually contained in an inactive body. Moreover, this company considers that high scholarship is insufficient unless the student also has shown leadership in school activities, for leadership after leaving college will depend largely upon ability to mix and co-operate with his fellow men.

In endeavoring to arrive at any conclusion in a matter of this kind, much depends upon the yardstick used as a measure for the successful engineer. It is true that many men have made material contributions to the engineering profession while little known and receiving small compensation. The abilities of such men have generally shown a one-sided development. But if success is to be measured by influence in the profession and earning capacity, the qualities enumerated are likely to prove most essential. This may easily be checked by reviewing the characteristics of prominent engineers among one's acquaintance.

Portland Cement Production in November

Production of portland cement in November was 12,600,000 bbl., an increase of 11 per cent over November, 1922, according to the latest bulletin issued by the United States Geological Survey. For the eleven months ending November 30, production was nearly 127,000,000 bbl. or 12 per cent more than ever before for a similar period.

A seasonal falling off is shown in shipments for the month, the movement from the mills being 10,251,000 bbl. Shipments for the eleven months' period exceeded 129,000,000 bbl., an increase of more than 17,000,000 bbl. over the corresponding period of 1922, the best previous record.

Notwithstanding the remarkable demand experienced this year, production has been relatively greater and stocks of finished cement in manufacturers' hands on November 30 were nearly 7,000,000 bbl., an increase of 30 per cent over last year.

Current Material Prices

Iron and Steel Prices

(From the Iron Age, Dec. 13, 1923)

Prices as of Dec. 11, f. o. b. Pittsburgh:

Open hearth rails, heavy, per gross, ton	$43.00
Light rails (25-45 lb. section), per 100 lb.	2.25
Track spikes, 9/16 in. and larger base, per 100 lb.	$3.00 to 3.15
Track spikes, ½ in., 7/16 in. and ⅜ in., 100 lb.	$3.15 to 3.25
Track spikes, 5/16 in.	3.15 to 3.25
Spikes, boat and barge, base, per 100 lb.	$3.25 to 3.50
Track bolts, ¾ in. and larger, base, per 100 lb.	$4.00 to 4.25
Track bolts, ½ in. and ⅜ in., base, per 100 lb.	$5.00 to 5.50
Tie plates, per 100 lb.	2.55 to 2.60
Angle bars, base, per lb.	2.75

Finished Iron and Steel

	Per lb. to large buyers. Cents
Iron bars, Philadelphia	2.67
Iron bars, Chicago	2.40
Steel bars, Pittsburgh	2.40
Steel bars, Chicago	2.50
Steel bars, New York	2.74
Tank plates, Pittsburgh	2.50
Tank plates, Chicago	2.60
Tank plates, New York	2.74
Beams, Pittsburgh	2.50
Beams, Chicago	2.60
Beams, New York	2.74
Steel hoops, Pittsburgh	3.00

Freight Rates

All rail freight rates from Pittsburgh on domestic shipments of finished iron and steel products, in carload lots, to points named, per 100 lb., are as follows:

Philadelphia	$0.32
Baltimore	0.31
New York	0.34
Boston	0.365
Buffalo	0.265
Cleveland	0.215
Cleveland, Youngstown, comb.	0.19
Detroit	0.29
Cincinnati	0.29
Indianapolis	0.31
Chicago	0.34
St. Louis	0.43
Kansas City	0.735
Kansas City (pipe)	0.705
St. Paul	0.60
Omaha	0.735
Omaha (pipe)	0.705
Denver	1.27
Denver (pipe)	1.215
Pacific Coast	1.34
Pacific Coast, ship plates	1.20
Birmingham	0.53
Memphis	0.56
Jacksonville, all rail	0.70
Jacksonville, rail and water	0.415
New Orleans	0.67

Rails and Track Supplies at Chicago

Standard Bessemer and open-hearth rails, $43; light rails, rolled steel, 2.25c, f. o. b. makers' mills.

Staidard railroad spikes, 3.10c mill; track bolts with square nuts, 4.10c mill; iron tie plates, 2.55c mill; steel tie plates, 2.60c f. o. b. mill; angle bars, 2.75c, f. o. b. mill.

Jobbers quote standard spikes out of warehouse at 3.75c base and track bolts, 4.75c base.

Cement Prices

Quotations as of Dec. 1, per bbl., in carload lots, exclusive of package:

Pittsburgh	$2.19
Cincinnati	2.41
Detroit	2.37
Chicago	2.10
Milwaukee	2.25
Duluth	2.19
Minneapolis	2.42
Davenport, Ia.	2.33

Cross Tie and Lumber Prices

(From Lumber, Nov. 9, 1923)

White Oak Ties

F. o. b. cars, Chicago, Nov. 7)

No. 5—7x9x8	$1.80
No. 4—7x8x8	1.65
No. 3—6x8x8	1.50
No. 2—6x7x8	1.40
No. 1—6x8x8	1.30

Red oak ties, 10@15c less than white oak. Sap pine and sap cypress, 10c less than red oak.

White oak switch-ties, per M. ft. $55 to $58

Red Oak switch-ties, per M. ft. 49 to 51

White Oak Ties

F. o. b. cars, St. Louis, Nov. 8

No. 5—7x9x8	$1.60
No. 4—7x8x8	1.47
No. 3—6x8x8	1.30
No. 2—6x7x8	1.20
No. 1—6x6x8	1.10

Red oak ties, 10c per tie less than white oak prices. Heart pine and heart cypress, same prices as red oak. Sap pine and sap cypress, 25c less than white oak.

White oak switch ties, per M ft.	$46.00
Red oak switch ties, per M ft.	42.00

Bridge and crossing plank, same prices as switch ties.

Market Prices of Lumber

	Flooring, 1x4, No. 1 Common	Flooring, 1x4, No. 2 Common	Timbers, 6x6	Timbers, 12x12
Boston—Yel. Pine	.....	.....	$53.00@57.00	$63.00@66.00
New York—Yel. Pine	$56.00	$40.00	50.00@52.00	57.50@63.00
Buffalo—Yel. Pine	51.00	31.50	.....	46.00@51.50
Chicago—Yel. Pine	46.00	30.00	.....	51.00
St. Louis—Yel. Pine	43.00	26.00	.....	41.50
Seattle, Wash.—D. Fir	56.00	52.00	26.00	.....

Southern Mill Prices

	Flooring, 1x4, No. 1 Flat	Flooring, 1x4, No. 2	Timbers, No. 1, 4x4 to 8x8	Timbers, No. 1, 3x12 to 12x12
Alexandria—So. Pine	$38.50	$26.25	.....	.....
Birmingham—So. Pine	41.15	19.17	.....	.....
Hattiesburg—So. Pine	38.61	19.30	$20.86	$24.97
Kansas City—So. Pine	.....	25.27	29.97	40.12

Construction Features of Colonization Railway in Canada

Recent Developments on the Temiskaming & Northern Ontario Ry. Described in Paper Presented Nov. 29, Before Toronto Branch of Engineering Institute of Canada

By S. B. CLEMENT,
Chief Engineer, Temiskaming & Northern Ontario Railway Commission, North Bay, Ont.

In 1902 the legislature provided for the construction of the Temiskaming & Northern Ontario Ry. "from a point at or near North Bay to a point on Lake Temiskaming." The railway was in operation to New Liskeard in January, 1905, but in the meantime the Dominion Government had undertaken the construction of the National Transportation Railway from Quebec to Winnipeg across the "Clay Belt" and the legislature had authorized the extension of the T. & N. O. to connect with the Transcontinental near the Abitibi River. The operation of the railway to the junction at Cochrane commenced on Nov. 30th, 1908. Since then branch lines of the T. & N. O. have been built from Porquis Junction to the Porcupine gold area and to the great paper mill of the Abitibi Power and Paper Co. at Iroquois Falls. Two short branches have also been built through the farming lands in the Temiskaming District. The total mileage now operated by the T. & N. O. Ry. is 328, consisting of:

Main line—North Bay to Cochrane, 252 miles; and branch lines, 76 miles.

The net operating profit during the past year was 3 per cent, but when the railway's contribution to the wealth and prosperity of the province and the additional indirect revenue derived by the province, are considered, the balance sheet will be found to be on the right side.

Temporary Construction in Abitibi River Bridge, Mile 11.3.

Considerations in Selecting Route for the Extension.—In selecting a route for a further extension of the T. & N. O. Ry. for the purpose of developing the area between the Transcontinental Railway and James Bay, an endeavor was made to locate it through or convenient to areas that appeared to have the best prospects of an early industrial development. It was found that the most desirable route would be obtained by following the Abitibi River. This route would

be through the better drained areas most suitable for settlement, it would cross a number of large rivers at points where pulpwood and timber could be collected for manufacture or shipment and would be close to a number of large water powers, the development of which would lead to the establishment of pulp and paper mills or other industries.

It was also considered that any extension should be capable of being ultimately extended to a terminus on James Bay. The most suitable harbor on the bay was found to be in the estuary of the Moose with a site for a railway terminal on the west bank near Revillon's Post.

in January, 1922. The steel bridges are being supplied and erected by the Hamilton Bridge Works Co. of Hamilton. Grading having been practically completed for the entire 70 miles and track laid and ballasted to the bridge at the second crossing of the Abitibi River, 44.4 miles from Cochrane, it was recently found desirable to take the work out of the hands of the general contractor. This was done and since the first of November the Commission has been operating a triweekly construction service from Cochrane to Island Falls Junction at mileage 43, where connection is made with a spur line three miles long to the Hollinger Power Development now

Placing Span in Bridge at Mile 11.3.

The route located meets these conditions. Comparatively light gradients, ½ of 1 per cent have been obtained with maximum curvature of 4 degrees. The grading is quite light except in the vicinity of Abitibi Canon, about 75 miles from Cochrane, where there will be 4 or 5 miles of heavy excavation, mostly in sand. The numerous river crossings will require comparatively heavy bridging.

First 70 Miles Under Construction.—Only the first 70 miles from Cochrane are at present under construction. A general contract for clearing, grading culverts, bridge foundations, tracklaying and ballasting was awarded to Messrs. Grant Smith & Co. & McDonnell, Limited, of Vancouver,

under construction at Island Portage, on the Abitibi River. Tracklaying and ballasting north of the second crossing will be completed by day labor next season.

The grading on this 70 miles was comparatively light, averaging about 16,000 cu. yd. per mile. There was no ledge rock excavation, except a few hundred yards in the bottom of two cuttings near the Sucker Creek crossing at mile 20. The grading may be grouped under two types characteristic of the clay belt; the alternate cut and fill on the broken ground along the river and lakes, and the long low fills from side borrow across the swamps and unbroken country.

Classification of Excavation.—All grading excavation was classified under three heads "Solid Rock," "Loose Rock" and "Common Excavation." These are defined in the specifications as follows:

"'Solid rock' shall comprise all detached rock or boulders measuring more than one cubic yard, and all rock in place requiring blasting to remove it."

"'Loose Rock' shall comprise all detached rock or boulders measuring more than one cubic foot and less than one cubic yard, and shale, slate and other rock which can be removed without blasting, although blasting may be occasionally resorted to."

"'Common Excavation' shall include all materials of whatever nature that do not come under the classification of 'Solid Rock' or 'Loose Rock.'"

The material in line cuttings with the exception of the solid rock previously referred to, was a glacial origin. It varied from extremely fine sands and clays to coarse boulders and from complex drifts to clays and sands of marked stratification. The classification of these materials under ths specification at times presents some difficulties, but it is doubtful that the problem is simplified by the use of a fourth or hardpan classification.

Embankments and Cuts.—Embankments are 18 ft. and cuttings 24 ft. wide, and both were trimmed to slopes of 1½ to 1. The slopes of a number of the cuts were not stable at this angle and there has been some slipping and sloughing off but the yardage involved was not great. After track was laid, those cuts were ditched with a steam railway ditcher, loading into air dump cars. A slope of 1½ to 1 is too steep for much of the clay. It is impracticable in railway construction to determine in advance the proper slope for each cut and it is more economical to subsequently ditch the cuts where necessary by the above method than to excavate all of the cuts to an unnecessarily flat slope.

Abitibi River Crossing at Mile 11.3 from Cochrane, Ont.

There were no serious land slides. The slips in the cuts already referred to merely filled the side ditches and did not cover the rails. In making fills across creek beds, there were some settlements of the heavier filling through the muck to a firm bearing, the displaced material rising on either side. In a few instances during ballasting operations there were settlements of muskeg embankments. It does not appear to be practicable to anticipate these settlements. Although the muskegs are deeper and softer where the timber is sparse and stunted and wide cross-logging may be used under the embankments where

considered necessary, generally this type of sink hole develops where least expected.

Track Construction.—Track, on the extension, is laid with 80-lb. A. S. C. E. Section rail and heat treated angle bars and bolts and all curves are fully tie plated. The ties are of untreated jack pine, 18 to 20 per 33 ft. rail, depending upon the size. Passing tracks are located at intervals of about 6 miles. In the switches of passing tracks No. 11 spring frogs and 22 ft. switch points are used. All other switches have No. 8 and 15 ft. switch points.

Sand or gravel suitable for ballast was not found in quantity along the line of the railway. Some difficulty even was encountered in finding material suitable for trestle filling. Except for a small quantity of selected material obtained from the trainfill pits, the bulk of the ballast had to be hauled from a pit 3 miles south of Cochrane. The scarcity of gravel will also make it necessary to haul ballast long distances in the event of the further extension of the railway to James Bay.

Concrete Work.—By reason of the scarcity of material suitable for aggregate for concrete, only a very few structures could be built in advance of tracklaying, and, except at the two large bridges over the Abitibi River at mileages 11.4 and 44.4, track was carried over the streams on temporary structures.

The proportions of the concrete used were:

	Cement	Fine Aggregate	Coarse Aggregate
For reinforced concrete or concrete deposited under water	1	2	4
Mass concrete in forms	1	2½	5
Foundation Concrete	1	3	6

The aggregate largely came from a gravel pit about ½ mile from the track and 5 miles north of Cochrane. Fine aggregate predominated in the pit gravel and, to obtain proper proportions, a sufficient amount of screened, coarse aggregate was added.

Foundation Construction Abitibi River Bridge at Mile 44.4.

Culverts.—Reinforced concrete or corrugated iron pipes up to 3 ft. in diameter were used for the smaller waterways, and as far as practicable were teamed in the winter and placed in advance of the grading.

Reinforced concrete flat top culverts were used where a greater opening was required than could be provided by a double 36-in. pipe culvert. Standard plans of concrete culverts are reproduced. Theoretically, arch culverts are more economical in material, but a slight settlement of either bench wall results in serious cracks, if not in the complete failure of the arch. It is

difficult to avoid settlement when built on the softer clays, even when piling is used and to repair or rebuild a broken culvert under a high embankment and maintain traffic, is a costly proceeding. Scrap rail reinforcing is used throughout in this type of culvert. In many cases sufficient rail is used in the tops to carry the load and the concrete merely serves as a protection.

Landslides in Clay Belt.—Landslides along the banks of many of the rivers in the clay belt have been of frequent occurrence. A recent slide on the Blanche River in the Fifth and Sixth Concession of Evanturel, is of sufficient interest to be briefly described. This slide effected the west bank of the river for almost ½ mile and extended back, in places, for several hundred feet, and covered an area of about 50 acres. The original bed of the river was blocked and the water dammed back until it flowed over the narrow flood plain on the east side. At the lower end of the slide, the bed of the river rose vertically about 40 ft., while at the upper end, the original river channel was filled by the movement of the west bank. The slide appears to have been due primarily to the flowing of an underlying stratum of very soft viscous clay. The overlying stratified clays broke along horizontal and vertical planes. A bridge abutment was moved about 200 ft. horizontally and 40 ft. vertically.

Bridges.—In crossing the larger streams, the use of high bridge abutments was avoided where possible, particularly on unstable material or on steeply sloping banks.

Where foundations are good, as on solid or loose rock, and within certain limitations as to height, a reinforced concrete abutment with concrete slabs has been successfully used and is more economical than a U type abutment.

All bridges were designed for E-60 loading and in accordance with Canadian Engineering Standards Specification with B. C. Fir decks.

The bridge of the first crossing of the Abitibi River, mile 11.3, consists of one 75 ft., two 110 ft., and three 90 ft. deck plate girder spans, supported on concrete piers and abutments. The footings in all cases were on hard pan. In the design of the bridge, provision was made for the raising of the level of the river that would follow the development of the Long Sault Rapids water power. A pool elevation at approximately the level of the tail race at the Iroquois Falls plant of the Abitibi Power and Paper Co. was assumed, and in anticipation of navigation of this pool, a clearance of 14 ft. was provided. Apart from this restriction longer deck truss spans in place of the 110 ft. plate girders could have been used.

Erecting Deck Truss Span for Bridge at Mile 44.4.

Satsifactory concrete gravel was found on each side of the river within teaming distance. Simple concrete mixing plants were installed on the top of each bank. The south abutment and piers No. 1 and No. 2 were poured from the south bank and the other piers from the north bank, all but pier No. 2, in advance of tracklaying.

In this structure there are 869,519 lb. of steel and 3,142.5 cu. yd. of concrete.

An unexpected summer flood of unprecedented volume swept away the cofferdam for pier No. 2. The work on the other piers was well advanced and to avoid several months delay to tracklaying, temporary construction was used in place of the 110 ft. D. P. girders between piers No. 1 and No. 3. Three 55 ft. D. P. girder spans already fabricated for one of the steel viaducts and a short length of timber trestle at each end were used to span the opening. Timber bents built on the cribs of the cofferdam supported the abutting ends of the girders, thus avoiding the placing of piling in the deep and swift channel. On the completion of the pier, the temporary work was removed and the 110 ft. spans placed in permanent position. The timber in the temporary structure was used again elsewhere for false work.

The Bridge at Mile 44.4.—The other crossing of the Abitibi River is at mile 44.4, midway between the Carrying Places and Island Portage. On the completion of the Hollinger Power Development at Island Portage, which is 1½ miles below the bridge set, the level of the water will be raised to the foot of the Long Sault Rapids. A 220 ft. deck truss spans the present river channel and clears the regulated water level by 7½ ft. Deck plate girder approach spans provide additional clearance for navigation. The total length of the bridge, 670 ft., comprising five 55 ft., two 35 ft., and one 100 ft. D. P. G. span and one 220 ft. deck truss span.

The steelwork is carried on concrete piers and pedestals, all of which are on solid rock except the south abutment and adjacent pedestals, which are on hardpan. All concrete was mixed in a plant at the top of the south bank and was spouted to and then elevated at piers "C" and "A." Concrete for the north end was spouted to cars and trammed across a suspension bridge and then elevated and spouted to the forms. This suspension bridge was so adjusted that both loaded and empty cars crossed by gravity, except for the last few feet at each end, where they required a little assistance.

The erection of the truss span involved the placing of falsework under considerable difficulty. The current is very swift and deep and the bed of the river is bare rock. To hold the piles for the falsework, cables were stretched across the river between the main piers. Staging on these cables held the top of the piles while the bottom of each pile was held against the current by a long wire anchored to a projecting rock, a short distance above the bridge. On these piles, timber towers were built under the alternate panels.

In this structure there are 1,615,-123 lb. of steel and 3,685.8 cu. yd. of concrete.

The Swastika Branch.—The T. & N. O. Ry. Commission also has under construction a railway of quite different type from that which has just been described. This branch extends from Swastika east through the Kirkland Lake gold area to Larder Lake, a distance of about 24 miles. A number of years ago the Commission obtained all the capital stock of the Nipissing Central Ry. Co., which operated an interurban electric railway between Cobalt and Haileybury, but held a Dominion charter with rights to construct a number of additional lines in Northern Ontario and Quebe. As the route of one of these lines was well adapted to the purpose, it was utilized and the Swastika-Larder Lake Branch is being built as a Nipissing Central line.

In the construction of this branch maximum grades of 1½ per cent compensated for curvature and maximum curves of 12° are used. The country through which it is being built is the rugged pre-Cambrian country, typical of the height of land where there is no general covering of clay as in the Clay Belt. Total grading quantities average about 12,000 yd. per mile, about 30 per cent of which is solid rock. There are no structures of importance, the largest being small plate girders designed for Cooper's E-50 loading. The general contractor is the Sinclair Construction Co., Toronto.

The Electrically Operated Coal Pier of Western Maryland Ry.

One of the Most Recent Railway Terminal Projects Described in Electric Journal

By R. W. McNEILL
General Engineering Department, Westinghouse Electric & Manufacturing Co.

This new pier utilizes the site and foundations of the original gravity pier of the company at Port Covington, Baltimore, Md., which was built in 1904 and destroyed by fire in September, 1919. The original pier was of the timber trestle type, with 40 coal pockets—20 on each side—through which coal was transferred directly from cars to ships by gravity. This pier was 60 ft. high and 1,200 ft. long, extending 729 ft. out from the shore on timber piles.

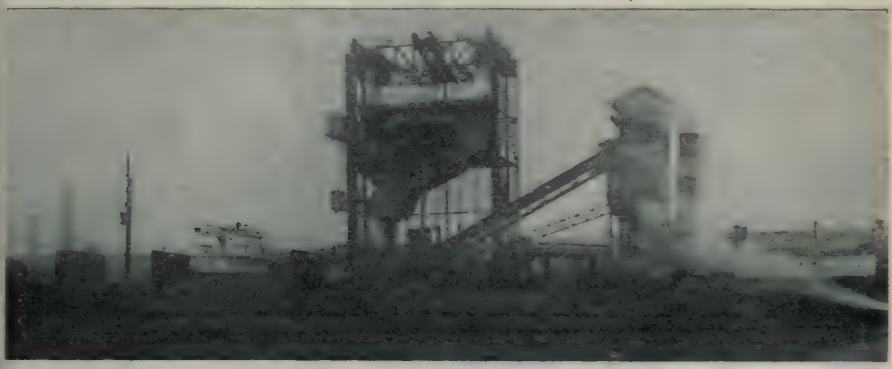

Fig. 1. Loading a Ship at the New Western Maryland Coal Pier.

As about 70 per cent of the tonnage handled by the Western Maryland Ry. is coal, a large part of which is for vessel delivery, it was imperative that all unnecessary delay in replacing the destroyed pier be eliminated. Not only was it necessary to provide a pier immediately for handling the current business, but new developments in coal fields tributary to the company's lines in Maryland, West Virginia and Pennsylvania were promising a large amount of new business, facilities for handling which should be provided in the new pier.

In deciding upon the location for the new pier, it was found that there were many advantages offered by the original site. Investigation showed that the piles which had supported the old structure had not been damaged below the water line by the fire, and were well preserved, thus offering good foundations ready for immediate use. The channel used by vessels approaching the pier was in good condition. By making slight modifications in arrangement and grading, the yard tracks used with the old pier could be utilized. Also, the site was conveniently located with respect to the other piers of the company, so that vessels loaded with merchandise freight at an adjacent pier could be moved to the coal pier for cargo or bunker coal by the ship's crew without the aid of a tug. As the tug expense is about 1 ct. per gross vessel ton, this made the location attractive to the steamship companies.

Selection of Type of Coal Pier.—Before proceeding with the construction of the new pier, practically every known type of coal pier was carefully considered. The problem was to select a type of pier which would be suited to local conditions, economical as to cost and maintenance, and capable of handling not only the existing volume of business, but also a materially increased future business.

Every phase of the situation was thoroughly investigated, as it was highly important that facilities be provided that would handle the normal business efficiently and economically, and would also accommodate a large peak business without an excessive increase in the cost of labor per ton of coal handled. This analysis showed that it was desirable to provide a pier having as few moving parts as possible, in order to avoid delays and excessive maintenance costs; and that the facilities should be capable of loading vessels with maximum speed and minimum breakage of coal, because efficiency along these lines would be attractive to prospective shippers. Quick loading enables the steamship companies to make a more rapid turnover of their vessels, and allows the railway company to release its rolling stock more quickly, thus permitting an increased movement of tonnage with the same number of ships and cars. The effect of the unloading equipment on the rolling stock also had to be considered, as with the method of unloading coal used at the old pier, cars were badly damaged by men using picks and bars, and beating on the sides of the cars with mauls in order to loosen the coal.

Careful estimates involving the various types of piers and equipment available for the unloading of coal cars and the mechanical loading of barges and ships were prepared before the type of equipment finally decided upon was selected. To have installed a steam-operated pier would have required the construction of a power plant. This was considered undesirable, as the railway company already had a very favorable contract with the electric company in Baltimore for supplying their grain elevators, and they found that by increasing their power consumption on the schedule already in force they would be able to obtain a still more favorable rate, so that they could not afford to install a plant of their own for either a steam or electrically operated pier.

Fig. 2. View of Pier Showing Inclined Rail Approach.

Pier Equipment.—Estimates showed that the pier equipment finally decided upon would be the most economical from the standpoint of capital invested, depreciation, insurance and operating charges. As shown in Figs. 1 and 2, the equipment of the new pier consists of a stationary car

dumper of the lift and turnover type, with mechanical trimming apparatus for loading boats directly from the dumper bin, and an auxiliary conveying system and trimming apparatus to permit the loading of boats on the side of the pier opposite that on which the dumper pan is located. All of the pier equipment is electrically driven by direct-current motors, power being supplied at 230 volts from a 1,500 kw. rotary converter sub-station located on the pier.

Operation of Pier.—The operation of the pier is of a special interest, not only on account of its size, but also on account of the fact that very little manual labor is used in its operation. With the pier in operation the loaded cars are fed to the pier from an extensive trackage system located on the shore, a switch engine being used to move the loaded cars and deliver them to the foot of the inclined approach to the dumper. At this point they are picked up by a "Barney" or "mule" hoist and moved up the incline until they rest in the cradle of the dumper, the operation being such that the loaded car kicks an empty car off the platen of the cradle, the empty descending at a slight grade to a "kick-back," which reverses the motion of the empty and sends it back through an automatic switch to the "empty" track, which is built on an incline so as to return the empties to the yard by gravity.

As soon as the loaded car has been properly stopped on the cradle the operation of the cradle hoist is started. The starting of the hoist automatically shoves the car, which is now resting on a platen mounted on rollers, over to the side of the cradle and clamps it accurately in the cradle, after which the cradle starts on its upward trip. When near the upper limit of travel the cradle strikes a turn-pin and starts overturning, continuing until the car has been turned through approximately 150 degrees, and spilling the coal on to a pan, which in turn empties into a chute reaching into the hold of the vessel being loaded. Fig. 1 shows the dumper with a car completely overturned in the dumping position, and with the end of the loading chute in the hold of a vessel.

Control of Operations.—The major operations of the pier are controlled by three operators. One of these controls the position of the ship or barge by the operation of a winch which moves the boat either forward or backward. This operator is located in a cab on the dumper structure, so that he has an unobstructed view of the boat and the dumper equipment. A second operator is located higher up on the dumper structure, and from this point he controls all of the main operations of the dumper equipment. Fig. 4 shows that this second operator has five master controllers in front of him. By the proper operation of these controllers this operator controls the movement of the Barney hoist, the Barney hoist gate mechanism, the cradle hoist, the pan hoist and the pan girder hoist. The operating levers for the master controllers are shown in the upper part of the illustration, while lower down are the brake levers for the operation of auxiliary mechanical brakes on the Barney hoist, cradle hoist, pan hoist and pan girder hoist.

The third operating cab is located on a boom which forms an extension of the inclined pan into which the car is dumped. From this cab, which is shown quite clearly in Fig. 1, the operator has a clear view into the hold of the ship which is being loaded. This operator controls the trimming of the ship, that is, the manner in which the coal is distributed within the hold. The dumper pan is equipped at its lower end with a telescopic chute, and at the end of this telescopic chute there is located a small conveyor belt running at moderately high speed, so that it will deliver the coal at some distance from the mouth of the chute. That is, the conveyor belt is used to carry the coal horizontally within the hold of the ship. By means of control apparatus which this operator has in front of him, he controls the raising and lowering of the telescopic chute, the speed of the conveyor belt and the direction of discharge, the belt being so arranged that it can be conveniently pointed in any direction within the hold of the ship. This means that no men are necessary to stow the coal within the hold of the ship. While it is necessary to have other men around the pier equipment to take care of emergencies and certain routine work, such as cleaning, repairs, sprinkling coal, etc., the main work of the pier is carried on by the three operators lo-

cated in the control cabs as mentioned.

Equipment.—From the viewpoint of the power required for its operation, the cradle hoist forms the most important unit of the pier equipment. It is driven by four 275 h. p. 230 volt series-wound motors of the ventilated mill-type construction. These motors are connected in pairs to a countershaft which drives the main hoist drums. The motors are located two in either end of the main machinery room and drive the countershaft, which extends the whole length of the machinery room through single reduction gearing. This countershaft in turn drives the two hoisting drums, one located at either end of the machinery room, through double reduction gearing. The hoisting drums in turn operate the cradle, four cables being attached to each drum for this purpose.

The control equipment for these cradle hoist motors consists of four full magnetic controllers for controling the four motors in parallel from a single master controller. The control is similar to the hoist controller on a crane, and is designed to give power operation in hoisting, and dynamic braking in lowering. Automatic slow down as the dumper cradle approaches the turning pivot is provided by means of track limit switches mounted on the pan girder. Automatic stopping of the cradle as it reaches the full dumping position is taken care of by means of similar limit switches.

The next machine in point of size is the mule hoist, whose function is to deliver the loaded cars to the platen of the dumper. This mule hoist is made necessary by the trackage arrangement, which has to provide for returning the empty cars to the yards after dumping. This means that the dumper must be located at a considerable height above the yards, as it is necessary to return these cars by gravity. This location of the dumper at an elevation greater than that of the yards makes it necessary to provide a hoist of some sort to place the loaded cars on the dumper. In the present case use is made of what is know nas a "mule" or Barney hoist. This consists essentially of a hoisting machine which hauls a small Barney or mule, which is used to push the loaded cars up the incline. The mule runs on tracks independent of the main tracks, and by means of an ingenious gate arrangement, it goes down into a pit under the loaded car at the lower end, comes up again behind it and pushes it up the incline. In this particular case the Barney haul is operated by two 275 h. p. 230 volt compound wound motors.

The control of the two Barney haul motors is accomplished by means of two full magnetic type controllers designed to control the operation of the two motors in multiple from a single master controller. This controller is of the plain reversing type with armature shunt points provided for slow-speed operation. The principal feature in connection with the Barney haul control equipment is the method used for interlocking with the Barney gate control equipment and the methods provided for automatic slow down. This is accomplished by the use of geared limit switches of the traveling nut type. The Barney gate mechanism is also provided with a limit switch of the same type, and the scheme is worked out so that it is impossible to move the Barney before entering the track gates unless these gates are in the correct position. The same switch also gives slow down when approaching the upper limit of travel.

The next machine in point of size on the pier equipment is the pan hoist. This is operated by a 275 h. p. 230 volt series motor and is controlled by a full magnetic reversing type controller designed to give dynamic braking in the lowering direction. Other machines on the dumper consist of a pan girder hoist driven by an 80 h. p. 230 volt series motor, a boom hoist driven by a motor of the same rating, a chute swinging hoist driven by a 12 h. p. 230 volt series motor, a hopper plate hoist driven by a 6 h. p. series motor, a telescopic chute hoist driven by a 30 h. p. series motor, a trimmer rotator driven by a 6 h. p. series motor and a trimmer conveyor driven by a 40 h. p. compound motor. In addition there are two boat haulage machines, each driven by a 40 h. p. compound wound motor.

As an auxiliary to the car dumper, the pier is equipped with a conveying system, a small storage bin and an auxiliary chute and trimming device.

This auxiliary equipment permits the bunkering or loading of a vessel on the side of the pier opposite that on which the dumper is located. To put this auxiliary equipment into service, the hopper forming part of the main dumper pan is designed with a movable bottom plate in such a way that when this plate is hoisted the neck of the hopper connecting with the loading chute is cut off, and the coal is converted to a stationary hopper discharging on to a pan conveyor which forms the first conveyor of a four-conveyor system. This conveyor is the largest and longest of the four; it runs parallel with the dock and elevates the coal to a point near the end of the dock, where it discharges into two cross conveyors known as No. 2 and No. 3. No. 2 conveyor discharges into a storage bin, while No. 3 discharges into No. 4, which forms part of a loading boom equipped with a trimmer mechanism similar to that forming part of the main loading boom. The bin into which No. 2 conveyor discharges has bottom openings for discharging on conveyor No. 3, the function of the bin being to supply a small amount of storage, to permit the bunkering of vessels without interrupting loading operations at the main loading chute. No. 1 conveyor is driven by a 200 h. p., 425 r.p.m., 230 volt shunt motor; No. 2 by a 100 h. p., 850 r.p.m., 230 volt shunt motor; and Nos. 3 and 4 are each driven by a 75 h. p., 850 r.p.m., 230 volt shunt motor, the motors being duplicates except that No. 4 is provided with grease lubrication to take care of conditions arising from the tilting of the boom. All of the conveyor motors are controlled by automatic controllers of the push button type.

This equipment has been in service for some time and is giving excellent results. Peak loads with all of the dumper equipment in operation run about 6,700 amperes at 250 volts in the sub-station. Power consumption amounts to aproximately 440 kw. hours per hour when working at the maximum rate. With the average operation and the equipment working 7¾ hours, the total power consumption measured on the alternating-current side at the sub-station was 3,100 kw. hours. Although the capacity of the driving motors for the various units of the equipment has been given previously in this article. Table I presents this information in a more compact form.

The dumper is designed to handle 100 ton capacity cars, although at the present time 50 ton capacity cars are being used. It is estimated that the maximum amount of coal that can be handled with 50 ton capacity cars per day (two 10-hour shifts) is 25,000 to 30,000 tons; and with 100 ton capacity cars this would be increased to 40,000 to 50,000 tons per day.

The writer wishes to credit that part of the foregoing information dealing with the history and economical problems in connection with the building of the pier to Mr. H. P. Pratt, chief engineer of the Western Maryland Railway Co.

Table I—Motor Ratings

	No. of Motors	H. P. Rating	Speed	Type	Total H. P.	Control
Mule haulage hoist	2	275	425	Compound	550	Auto-Mag.
Mule haulage track gates	1	12	915	Series	12	Auto-Mag.
Cradle hoist	4	275	425	Series	1100	Auto-Mag.
Pan girder hoist	1	80	480	Series	80	Auto-Mag.
Pan hoist	1	275	425	Series	275	Auto-Mag.
Chute swinging	1	12	700	Series	12	Manual
Boom hoist	1	80	480	Series	80	Auto-Mag.
Hopper plate hoist	1	6	1050	Series	6	Manual
Telescopic chute hoist	2	30	525	Series	60	Manual
Trimmer rotating	2	6	1050	Series	12	Manual
Trimmer conveyor	2	40	900	Compound	80	Manual
Hopper gate	1	20	515	Series	20	Manual
Boat haulage	2	40	540	Compound	80	Manual
Conveyor	1	200	425	Shunt	200	Auto-Mag.
Conveyor	1	100	850	Shunt	100	Auto-Mag.
Conveyor	2	75	850	Shunt	150	Auto-Mag.
Total rated horsepower					2817	

The Economics of Railway Electrification

A Paper Presented Sept. 10 Before the Western Society of Engineers

By E. MARSHALL,
Electrical Engineer, Great Northern Ry.

Most of us are familiar with the reasons why railroads should electrify; the saving in fuel; less maintenance cost of locomotives; doing away with roundhouses, fuel stations, water stations, etc. In the light of what the electric locomotive has done and is capable of doing, the steam locomotive —the evolution of the crude machine first applied to haulage on railroads, with all the above appurtenances, seems to be rather primitive. And yet we see railroads not only not availing themselves of the electric locomotive to any considerable extent but apparently becoming more and more committed to the steam locomotive and its inherent limitations. In other words, the trend of things does not seem to be toward the electric locomotive, in spite of the considerable number of electrical installations in the country and their successful performance.

Electrification to Remove Operating Trouble.—When the B. & O. R. R. electrified its Baltimore tunnels in 1895, it broke into the field of the steam locomotive, and solved a very distressing problem for themselves, and it was accepted by very many people as the forerunner of the day, not for distant, when the steam locomotive should be no more. This was over 28 years ago, and I believe that very few people expected to have to wait that length of time to see the iron horse extinct. Yet the fact is that the real horse of flesh and blood is very much more nearly extinct.

Some ten years (or more) later came the New York Central and The New Haven with their New York City electrification. This was due to legislation following a disaster due to locomotive smoke. Later these were extended beyond the original limits for reasons which will appear later in this paper.

Other electrifications followed about as follows:

Pennsylvania R. R. (New York and Philadelphia).
Great Northern (Cascade Tunnel).
Norfolk & Western.
Boston & Maine (Hoosac Tunnel).
Grand Trunk (Port Huron Tunnel)
Chicago, Milwaukee & St. Paul.

In all the above except the last the impelling cause was tunnels and smoke, or in case of the Norfolk & Western, a very short congested district having traffic beyond the capacity of the trackage and no way out except to increase the speed of the trains very materially, which was not possible with the steam locomotive.

Electrification Useful Under Special Conditions.—Practically all of the above railroads were electrified for special reasons, not common to the ordinary railroad. True, electrifications once started have been extended beyond the original limits, but mainly in the effort to get some benefit from the large initial investment. A 5 or 10-mile electrification is a nuisance in that no operating expense is saved and a large addition is made to it. For an electrification to stand on its own feet, so to speak, it must extend over at least one operating division.

The Pennsylvania electrification in Philadelphia was necessary since the limit of the Broad St. station had been reached, and it was necessary to cut out all idle movements of trains and equipment, which the motor equipped passenger car is able to accomplish to almost 100 per cent. If this had been a through station, instead of at the end of a line, the chances are that the Philadelphia electrification would never have been made.

The Milwaukee electrification is in mountainous sections; it has not reached its limit of traffic capacity; it has no severe tunnel conditions. It is in competition with other railroads in the same territory successfully handling heavier traffic by steam, so that its case for the electrification of 650 miles is not fully established. Yet I know that as a means of handling the existing freight and passenger business, it is a perfect success. Undoubtedly at some future time it will prove equally successful as a financial undertaking.

In summing up then, as far as we have gone, it would appear that in the present state of the art the elec-

tric locomotive, or electrification in general, has proved that its field of usefulness is fully established in those special cases where the inherent limitations of the steam locomotive can not be tolerated, such as smoke, and its limit of capacity. And since smoke is not accounted such a great nuisance in the open county, nor is its limit of capacity such a serious matter on a moderate profile, it is still maintaining its lead and undoubtedly will for many years to come.

Higher Maintenance Reduces Savings.—It is true that the electric locomotive can enter any field that is occupied by the steam locomotive, and that the converse is not true, yet the fact is that it is not being generally adopted, and I think a little analysis will show why.

Taking the operating sheet of a large railroad for a recent year, we find that the percentages of the various operating accounts (expenses) are as follows:

Station Service	7.2
Yard Service	7.1
Engine Service	20.0
Train Service	7.2
Casualties	4.2
Miscellaneous Transportation	3.2
Maintenance of Equipment	22.2
Maintenance of Way and Structures	23.5
Traffic	1.1
General	2.6

By electrifying the road only a few of the above items would be affected to any considerable extent, viz., engine expense, maintenance of equipment, and maintenance of way and structures. The other items would be affected incidentally but not to any great extent.

The two largest items to be affected favorably are engine expenses—20 per cent, and maintenance of equipment—22:2 per cent. If we assume that engine expense would be reduced 50 per cent, and maintenance of equipment 20 per cent (M of E includes cars and other equipment as well as locomotives), we would therefore reduce the total operating expense by 14.6 per cent. And to do this we must electrify the entire railroad.

Practically, of course, this is absurd, and we know that we could avail ourselves of the greater part of these savings without electrifying the whole railroad, but the greater part of the main lines would have to be electrified. To do this would require an enormous increase in the capitalization, and a very large incidental increase in the item of Maintenance of Way and Structures. (The trolley or other contact system is not classified as Way and Structures, but as Power Distribution Systems, and the supporting structure as Power Line Poles and Fixtures by the I. C. C. accounts. But by any name whatever it is a structure that must be maintained.) This would go a long way toward neutralizing the 14.6 per cent saving shown above.

Electrification Justifiable in Spots.—My conclusions are, then, that electrification of railways under present conditions is justifiable in spots, and that it will be done slowly in the future as in the past. It is not at all justifiable to any wholesale extent as we, as electrical men, would perhaps like to see. For it to be otherwise there must be a vast change in conditions as we know them now, and I can foresee only the electrification of main lines of roads having very dense traffic in any event.

It is unsafe to set one's self up as a prophet, so I am not going to predict what is to be in the railroad world. Prognostications in the business world are only reliable when based on all the facts, and at present we do not know all the facts. Among many other things to be considered we must include the psychology of the mob. No one knows as yet what far-reaching changes will take place in the business and social world due to this and kindred causes.

Assuming, however, that we are going to stay safe and sane, or perhaps may become more so, we may conclude that the problem of electrification is going to be influenced by the growth of our great power systems. It is a fact that the cost of power is going to become more and more important, since civilization is requiring greater amounts of power per capita of population as time advances. It will therefore become necessary to reduce power waste and waste in its production. It will also become more important to utilize all possible sources of power, some of which are now going to waste.

Cheap fuel is gone, due to the tremendously increasing demands for fuel, and this problem is growing more important and serious from year to year. The increase in the efficiency

of power units is trying to keep step with the increasing cost of fuel, but it cannot keep up indefinitely.

Relation of Electrification to Super Power Development.—As a means of keeping down the cost of fuel used for power, or what amounts to the same thing, of getting more out of our fuel resources, the most promising is the super power systems. Provided our lawmakers do not regulate the power companies out of existence, or legislate against their growth, these power systems will develop into a supreme power system, which will collect power from all possible sources, even as Dr. Steinmetz has said, from local heating plants, which will produce power as a by-product of heating. This will, in itself, add enormously to the power resources of the country and proportionately conserve the fuel supply.

On our largest railroads, carrying dense traffic, electrified districts will take their power from the power system, while less busy lines and districts will continue to use the steam locomotive.

Shops Now Largely Electrified.—Another thought is interesting to follow. Twenty-five years or more ago, in advocating the use of electric power in shops, etc., the argument most used was that you could save power by eliminating belts, shafting, etc., and on Sundays, nights, etc., you would not have to run a lathe or any other single tool. Very good arguments, indeed, but this alone would not have electrified very many shops. The reason that practically all shops driven electrically today is that electrical drive revolutionized the shop methods and management due to individual drive. It is no longer necessary to keep the heavy machines nearest to the source of power but they can be located wherever they can be most efficiently operated. Increased efficiency and output is possible due to the possibility of scientific laying out of the shop and the logical routing of the material in process of manufacture. Tools have been speeded up and far greater utilization obtained of plant and labor employed. Tools have been modernized, due to the flexibility of the drive. In fact, the entire mechanical world has been revolutionized through electric power. The benefits of electric power are not that it saves power or that electricity is cheaper than steam, or that a greater percentage of the power originated is actually delivered to the tool, as is the corresponding argument for electric traction, but that it was able to revolutionize shop methods through scientific design of plant, tools and management.

Wholesale electrification of railways must come, if at all, as a consequence of the possibility of so increasing the output and efficiency of the plant, tools, management and men as to more than offset the increased capitalization necessary for its installation. The mere substitution of one kind of motive power for another, even if it costs less to operate, is not sufficient.

Opportunities for Improvement in Railroading. — Electrification does not need to mean merely the electrification of the tractive power, but all the facilities possible must be mechanized through electricity. To keep step with the growth of business and to keep its share of the transportation of the country, our railroad system has before it the necessity of creating additional facilities to give the service now being demanded. In providing this, electricity is the most logical factor.

The greatest chance for improved efficiency in railroading, to my mind, is in increased speed of movement, directly and indirectly: directly, by the greater speed of the trains, indirectly by quicker release of the goods transported to the consignee. This latter is a terminal problem and requires improvement of plant and method, and in its solution increased use of electric power would be a very great factor.

All this would have been in effect, undoubtedly, if the railways could have been on an equal footing, the past few years, with other lines of industry. If they had been as unhampered as others, we might now be witnessing a superior kind of transportation in which the electric locomotive would be playing a leading part. The immediate step necessary to secure better service from the railroads is to lay off of them legislatively, so that they may have greater incentive for self-improvement. The rest will take care of itself in due time.

The Training of Section Foremen

Committee Report Presented Sept. 19 at 41st Annual Convention of Roadmasters and Maintenance of Way Association

The growing importance of economy in all branches of railroad work accentuates the need of education. Notwithstanding acute periodic shortages of track labor, track foremen are required and expected to meet changing conditions.

The Benefits from Educating Foremen.—This calls for better education, the benefits of which are:

First—The creation of loyalty. The importance of loyalty cannot be overstressed. In time of storms or accidents, track foremen must necessarily take the initiative and lead their men into physical hardship, supported only by an appreciation of responsibility and duty. Disgruntled or disloyal men cannot be expected to render emergency service of this kind to the same degree as satisfied, loyal men.

Second—Sustaining interest. There are many artificial ways of creating interest in work, such as the offering of bonuses and introducing friendly competition. However, as a rule the interest created by these methods is short lived. Interest can be sustained more effectively through educational methods.

Third—Teaching men to think. No one will deny that a thoughtful man will accomplish more with the same expenditure of effort than a thoughtless one. To teach men to think is to teach them to arrange their ideas in logical sequence and to determine the correct values of the elements entering into every piece of work. Too frequently subordinate employees are placed at a disadvantage by their officers in the performance of work because they are not given the benefit of discussion which would clarify many points in doubt and enable the subordinates to perform the work more readily and satisfactorily. To this end the committee recommends that officers cultivate tolerance and patience in dealing with subordinates and believes that this attitude will do much to further education through personal contact. Men should be made to feel that it is to their credit to develop their subordinates and that this is a factor by which their worth is judged.

Every possible influence should be used to bring about uniform track forces, based upon a fair minimum. Work which can be performed during the winter months should be carefully studied and conserved for that period. Comment is hardly needed upon the difficulty of educating and developing men when there is a high labor turnover. When the continuity of work is doubtful, the good men are the first to leave, for they know that they can secure continuous employment elsewhere and their intelligence and ambition, the very traits that make them valuable to the railroads, lead them to seek other employment.

Many railroads have already established adequate differentials between the rates paid their foremen and their laborers. The incentive afforded laborers to remain in railroad employ and develop themselves into capable foremen is greatly enhanced by sufficient differentials. This feature should receive careful consideration in connection with the development and education of men.

Employment—The type of men employed frequently determines the extent to which they may be developed into foremen. In many industrial centers the track foremen have little opportunity to pick and choose. More often than not the number of men available is inadequate. This condition seems destined to continue. Because of this the committee feels that industrial centers are not a fertile field for the development of foremen. The solution offered is to attempt the more intensive education and development of laborers in agricultural and forested sections and to supply the industrial centers with foremen therefrom. It is appreciated that there are some lines which lie wholly within industrial sections and for whom this plan is not feasible. Such lines will have to make the best of the men they can develop and supply the deficit by recruiting men from other lines as is now being done to a large extent.

Apprentice Systems.—Some roads have experimented with an apprentice system with indifferent success. Some failures can be attributed to abuse, others can be charged to lack of interest and effort on the part of officers.

The committee feels that some practical apprenticeship system could be worked out and suggests the following scheme to be modified as conditions direct. Employ boys from 17 to 19 years of age with the usual minor's release. See that they have at least a common school education. Pay them two-thirds the laborer's rate the first year, the standard labor rate the second year, a differential of from 2 to 5 cents an hour the third year, and give them the title and pay of assistant foremen the fourth year. Boys who show no aptitude or interest in track work should not be encouraged to finish the apprenticeship, while those who do show these qualities should be encouraged and tutored, both by the foreman and supervisors. The first year should preferably be spent on an outlying section, the second year in an extra gang assigned to ballasting out of face, the third year in an extra gang laying rail and the fourth year in a terminal yard. Apprentices should be encouraged or perhaps assisted in taking a correspondence school course dealing with track work. They should be made entirely familiar with timekeeping, material records and the other clerical work devolving upon a foreman. Care should be exercised to see that no more apprentices were employed and developed than the road required to fill vacancies. This scheme would require close and interested supervision.

Rotation of Capable Men.—Capable men interested in track work should be given ample opportunity to learn all of the various phases thereof. Too frequently capable and reliable men who were good timber for development have preferred to stay on outlying sections because their early experience has not embraced extra gang and yard work.

Recognition of Ability.—Track foremen should be encouraged to turn their forces over to promising laborers occasionally in order to determine whether they have the requisite qualities for development into foremen. If they discover the necessary ability in these men they should continue to develop it until in their opinion the men are ready to qualify.

Personal Contact.—The necessity for economy in the performance of work and the use of materials compels a closer supervision which has not only developed a closer relationship and understanding between supervisors and foremen but has also expedited the development of the foreman.

Magazines.—Many roads have already adopted the practice of subscribing to magazines devoted to track and maintenance work for their foremen. The committee strongly endorses and believes individual subscriptions are amply justified in order that foremen may refer to back numbers when occasion demands. Supervisors should discuss interesting articles with their foremen in order to determine whether the magazines are being read and also in order that the greatest benefit will be derived from such articles.

Correspondence School Courses for Foremen.—When any foreman shows a disposition to improve himself by taking a correspondence school course dealing with his work he deserves encouragement. There are doubtless many foremen who are not aware that courses dealing with track work are obtainable and a supervisor interested in the development of his men should see to it that his progressive foreman, if not all of his foremen, know of the opportunity.

Conclusions.—That the need for and benefit to be derived from education as a means of developing men should be recognized and every advantage taken of educational methods.

That education creates and sustains both loyalty and interest and promotes economy.

That superior officers should be made to feel that it is their duty and to their credit to develop subordinates.

That every influence should be employed to stabilize the size of track forces in the interest of attracting better men for education and development.

That adequate and deserved differentials between labor rates and foremen's rates be established or re-established as an incentive for good men to look forward to and await promotion.

That apprenticeship systems merit study and consideration.

That the rotation of men through the various phases of track work to broaden their knowledge is desirable.

That foremen should be impressed with the important part they have in discovering good men and urged to respond to the obligation.

Rail Laying at Rate of 1 Mile Per Hour

Methods Used by Canadian Pacific Ry. Described in Railway Age

Using some unusual but effective methods, the Canadian Pacific Ry. recently laid over 100 miles of 100-lb. rail under traffic at the rate of a mile or more an hour and secured total daily mileages up to 10 miles and over. The work was carried out on a single track line of considerable curvature over which there was a regular and fairly frequent train service.

Since the adoption of 100-lb. R. E. rail in 1921, when 500 track miles were laid in one location, the Canadian Pacific has followed the practice of renewing by subdivisions, thus allowing considerable leeway in organizing the work. The rail laying described in this article included the work on one single track subdivision totalling 100.5 miles as a part of a program of 500 miles.

Thorough Preparation Necessary.—As the rail laying is done under traffic the preparation for the work is thorough in order that the actual tasks involved when rail is changed out shall be as few and as simple as possible. In connection with this preparation a number of improvements have been made in the methods for unloading and distributing rail, due to the development of some accessory equipment, principally roller bars for unloading and roller hooks for distributing. In this work rail was received on flat cars with an average load of from 60 to 80 rails. Under ordinary conditions it was simply rolled over the side of the car, remaining on the ballast shoulder. However, when this shoulder was narrow or where there danger of the rail rolling down into the ditches or where it was necessary, as on bridges and trestles, to leave the new rail close to the old, the special hooks were

Two of the Roller Bars Showing Them With and Without Hook to Go Over Ball of Rail.

utilized. These hooks are made in two sizes, a short one and a long one, and are suspended from the stake pockets of the car. Each contains a large roller upon which the rail is supported for a short time after being turned over the side of the car. One or both of these hooks are used at a time, according to the necessities.

Use of Hooks in Rail Distribution.—When both hooks are utilized the falling end of the rail drops into the roller of the longer and lower hook, where the full length of the rail is supported for a moment along the the side of the car in both hooks, after which it rolls out along the line of the train and with but little drop. The result is that the unloaded steel falls without jar, remains close up to the end of the ties for its full length and, as an added advantage, is evenly distributed. This plan is particularly advantageous on bridges and trestles, where the steel is distributed uniformly, safely and rapidly on the bridge deck without the necessity of any men other than those on the work train. In a recent observation of this work the train moved along steadily at about three to four miles an hour over two successive narrow and high trestles, leaving the new steel properly distributed on each side on the old, and with no damage to the steel or the bridge decking.

Organization for Distributing Rail.—The organization for the distribution consists ordinarily of four men to a car and from two to seven cars are unloaded at a time, according to the location and the traffic conditions. With the latter number three cars are unloaded on each side, each car taking every third rail and the odd car filling in misses, dropping extra steel for crossings, switches, etc. The train speed averages about three to four miles an hour, with an average output of from 30 to 70 cars a day on level track in open country to 25 to 30 cars a day in more rugged country.

Due to the use of the special roller bar which was developed on the Canadian Pacific by an extra gang foreman it is possible for four men to handle the unloading of one car at a rapid rate and without any particular effort. This bar is in reality a small, light weight "dolly" with projections to catch under the head of the rail and from either side. By means of this bar two men can roll a rail across the width of a car in quick time and with little physical effort. The organization of four men on a car consists of two men on roller bars, one man with a lining bar to help break the rail loose and to guide it across to the edge of the car, and a fourth man equipped with a rail fork to turn the rail over the side of the car or onto the hooks as the case may be. Two extra men with roller bars are needed to expedite the work on heavy curve territory on account of the superelevation of the track. Thus a complete rail unloading gang handling seven cars consists of the following in charge of a foreman:

Total Men	Duty	Me Pe Ca
14	Handling unloading bars	
7	Assistant on center of rail	
7	Rail fork turning over rail	
1	Knocking out stakes on side of car	
1	Emergency man on ground	
1	Water boy	
1	Cook	
32		

With this organization a minimum of 30 cars per day of 6 actual working hours is maintained regularly. An interesting sidelight on this method of unloading by the use of roller bars is the absence of personal injuries to the workmen. For example, about 80 miles of rail have been distributed since 1921, without the slightest injury to any of the men employed.

Method of Laying Rail.—Following the distribution of the steel the rails are picked up by a special gang and set up end to end on the ballast shoulders at the end of the ties, due care being taken to see that the joints fall in proper location. In order to speed up this work and secure a large mileage per day, two Three-Man rail layers were used with 12 men to a machine. These extra men greatly facilitated the work and permitted from five to six miles to be set up each day. Where the ballast shoulder was not entirely full or where the roadbed was springy, the rail was turned on its side with the ball towards the track being turned back on its base in advance of the rail laying gangs. The extra inside spikes used on curves were pulled next in order that the spiking on tangents and curves would be uniform and a uniform movement of spike pulling gangs insured. Joint bolts at switches, crossings and intervals of 15 to 30 rail lengths on curves were well oiled in preparation

for their easy removal when work was started.

The method of laying rail was to bar the old rail in towards the center of the track, leaving the tie-plates and outer spikes still in place. The new rail was then lifted into place and spiked down against the shoulder of the old tie-plates. This insured that the alignment and surface of the track would remain undisturbed, while a lesser concentration of men was needed and a greater output of work per day was secured. The new tie-plates were inserted later under traffic by extra section forces and extra gangs who adzed ties, plugged the old spike holes and fully spiked the track throughout. It is pertinent to mention in connection with the tie-plating that the Canadian Pacific uses soft wood jack pine and hemlock ties in which spikes can easily be driven or withdrawn. The slight extra labor of driving temporary spikes was thus overshadowed by the lessened delay in laying rail and by the non-disturbance of the track alignment and surface.

General Order of Operation.—In actual operation, the work proceeded in the following general order under flag protection: Two men preceded the gangs, unbolting the old rail at highway crossings and curves, etc. These men were followed by two gangs, one to each rail, pulling the spikes on the inside of the rail. These were followed by two other gangs who barred in the old rail towards the center of the track. This brought the operation up to the actual laying of the new rail and the method which has greatly increased the mileage laid per day. Double-size tong gangs were used on each line of rail, about 36 men or 18 tongs being the usual number to a rail unit. A rail unit consisted of two rails bolted together in advance, making a 66 ft. length as a maximum to handle. With a foreman in charge, the double rail unit was lifted by the tong men and set over on the old tie-plates, at the same time swinging it back against an expansion shim of proper thickness. The tong men then moved ahead to the next setup, the entire rail laying operation being built around the rate of speed at which they could work steadily.

The results of this method have shown that most of the time lost with tong gangs was in starting and stopping them, and that the tong men become tired quickly from carrying rail rather than from merely lifting it sideways into place. Bolting the two rails together resulted in a double unit still small enough to handle easily and cut the starting-stopping time in half. Careful preparation in the setting up of the new steel practically obviated the carrying of it more than a foot or two at the most. The effect of this plan has been that the tong gangs have been able to maintain practically the same average pace throughout the day with surprisingly little fatigue. Timed at various hours from early morning to late afternoon over stretches of from 10 to 20 rail lengths, it was found that the tong gangs were travelling at about 40 to 42 seconds per move, or at the rate of three rail lengths a minute or 180 rail lengths an hour. That this was done more or less easily was evidenced by the fact that when speeded up, each tong gang has maintained a pace for short periods of time of one move each 20 seconds, or at the rate of about 360 rail lengths an hour. During a good day where physical conditions were better than the average for this territory, a track mile of rail was laid in 28 minutes, more than once during the day, and a little over 10 track miles was laid during the day.

The tong gangs were followed by two gangs, one to each rail, equipped with lining bars and spike mauls who barred the new rail over tight against the shoulder of the old plates and spiked it down on the inside of the rail by driving spikes on alternate ties just outside of the tie-plates. Several men with adzes worked in and around the tong and spiking gangs to take care of the new joint ties, etc. The bolters followed behind these gangs putting on the remaining alternate joints and pulling them up tight, leaving all joints fully bolted. A small gang followed in the rear, checking up work and insuring that the track was ready for traffic.

How the Old Rails Were Handled.—The day's run was not considered complete, however, until the old rail had been thrown outside of the new steel, and for this purpose a work train and from two to four men were used.

With this method the loose ends of both old rails were lifted with a pair of tongs and lining bars over the new steel after which a work train, which was assigned regularly to the

rail laying gangs, was moved along the track at a speed of from three to four miles an hour, pushing in front of it a flat car loaded with short length rail, miscellaneous extra tools, etc. The tread of the leading rails on the first truck gradually pushed the old rail over and outside the new, leaving it on the end of the ties. For lubricating purposes, oil soaked waste was supported over each wheel by a wire by which the waste could be raised out of the way when not in use. Using the work train in this fashion, the old rail was thrown out smoothly and quickly and with practically no attention other than maintaining a steady pace. In general five miles an hour seemed to be about the most satisfactory speed for rail bolted up with angle bars. Where base supported joints were used, a number of men, usually two to a rail, equipped with light bars, gave the lower corner of the joint a slight upward spring as it approached the ball of the new rail, causing it to ride up and over the rail without catching. Under both conditions rail was thrown out at rates adjusted to suit the work, easily keeping up with the progress of the rail laying gangs, although only working during odd hours to fill out the day when the work train would otherwise have been idle in a siding. It is estimated that the use of a work train for this purpose replaced from 30 to 50 men at least, based on previous experience where 30 men were needed to keep up with gangs laying 5 miles a day. Incidentally, the work train helped to keep the forces closely bunched, prevented straggling and tended generally to speed up the work.

Typical Arrangement of Gangs.—While the organization varied somewhat according to the needs and conditions of the day's work, the following is fairly typical of the arrangement of the forces, which consisted of extra gang men:

1 Man.	Flagman.
6 Men.	Three on a side, setting up new rail on its base (when required).
2 Men.	Breaking joints.
2 Men.	With push car. Material for closing up track.
18 Men.	Nine on a side. One foreman. Pulling spikes.
1 Man.	Driving down broken spikes, etc.
16 Men.	Eight on a side. One foreman. Throwing in old rail (smaller number required on tangent track).
72 Men.	36 on a side. Two foremen. Two tong gangs.
3 Men.	Pulling spikes around joints of new rail.
2 Men.	Adzing when required.
64 Men.	32 on a side. One foreman. Bolting up joints.
48 Men.	24 on a side. One foreman. Spiking new rail.
1 Man.	Spiking loose ends of old rail (not required when work train follows gang closely).
10 Men.	One foreman. Special gang on highway crossings and cutting closures at switches, etc.
4 Men.	Checking up new work.
3 Men.	Helpers on work train throwing out rail. (Five men needed on curves where rail is broken often).
3 Men.	Carrying water.
1 Man.	Flagman.
257	Total.

When necessary to close track special 11-ft., 100-lb., 85-lb. switch points were used. In laying the new steel, allowance was made for creeping up the joints at the foot of grades, approaching water tanks, etc., and blocking it tight at the summits. Rail anchors were applied after rail laying by extra section forces. The rail laying forces were housed in boarding cars and were taken to and from work in three Colonist cars equipped with steam heat, attached to the work train. This materially reduced the possibility of sickness among the men and in addition permitted the utilization of the maximum available working time. Following the completion of the rail laying, the gangs were broken up into units of 30 to 50 men who inserted the new tie-plates and full spiked the track, averaging from 80 to 100 plates per man per day.

Locomotive Shipments in November

The U. S. Department of Commerce announces November shipments of railroad locomotives from the principal manufacturing plants, based on reports received from the individual establishments. The following table compares the November, 1923, figures with the previous month and with the corresponding month last year, as well as totals for the year to date, compared with a year ago, in number of locomotives:

	Locomotives.				
	Nov., 1923	Oct., 1923	Nov., 1922	11 mo. total Jan. to Nov. 1923	1922
Shipments					
Domestic	270	295	144	2,680	862
Foreign	29	15	15	180	202
Total	299	310	159	2,860	1,064
Unfilled orders (end of month)					
Domestic	656	915	1,501	.....	.....
Foreign	35	62	118	.....	.....
Total	691	977	1.619	.....	.....

Methods Employed by the Bureau of Valuation in Appraising Railway Lands

A Paper Presented Before the Western Society of Engineers May 7, 1923, and Published in the Proceedings of the Society for October

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It is not within the possibilities to get into a general discussion of methods of land valuation in this short paper, hence it will be confined to methods employed by the Bureau of Valuation, Interstate Commission, in appraising railway lands.

The valuation amendment to the Interstate Commerce Act as adopted in 1913 required the commission to ascertain a number of facts with regard to lands owned or used by common carriers. It also required an extensive co-operation on the part of the carriers in determining these facts.

Requirements of Interstate Commerce Act.—The amendment required the reporting in detail and separately from improvements, the original cost of all lands, rights-of-way and terminals owned or used for the purposes of a common carrier and separately the original cost of property held for purposes other than those of a common carrier, which latter requirement has been held to cover land, which, on the valuation date selected, was not put to a carrier use, or where the prospect of such use had not become imminent. Under this requirement the commission served upon the carriers what is designated as Valuation Order No. 7, which order requires the carriers to prepare schedules for each parcel of carrier and non-carrier land, showing the area, character of title, the cost and other pertinent information. The returns of original cost under this order were checked by the commission. Amounts paid for special assessments were excluded. Where the records did not indicate a substantial consideration, it was assumed that the lands were donated.

The amendment also required the commission to ascertain and report the amount and value of any aid, gift or grant of right-of-way made to any common carrier, or predecessor corporation by the federal government, or any other governmental agency, or any individual, together with the amount and value of any concessions or allowances made by common carriers in return for such aids. In order to make effective this requirement, the commission served upon the carriers what is known as Valuation Order No. 16, which required them to report in detail the information specified in the requirement.

The valuation amendment also required the commission to report the present cost of condemnation and damages or of purchase of all lands, right-of-way and terminals, as well as the present value of both carrier and non-carrier land. As a first step in carrying out these requirements, which are the more important ones, the commission served upon the carriers what is known as Valuation Order No. 1, specifying in detail the form and methods which should be used in preparing maps and profiles.

Organization.—The land section of the Bureau of Valuation, which section has conducted all land valuation work, was organized under a Supervisor of Land Appraisals at Washington and a Valuation Attorney at each of five valuation headquarters which were established at various points. Under these Valuation Attorneys were placed Land Appraisers of several grades. The most of the appraisal work in the land section was conducted with the organization in this form but about a year ago the district offices were abolished as were also the positions of Valuation Attorneys and the Land Appraisers have since that time reported directly to the Supervisor of Land Appraisals.

Present Value.—The instructions pertaining to land appraisals issued by the Supervisor stated that to aid in arriving at present value, appraisers are required to find the value of similar land adjoining or adjacent to that of the carrier. As a foundation for the Appraiser's work, the carrier

was required to supply a set of blue prints of maps prepared under Valuation Order No. 1. The Appraiser was under instructions to make a preliminary inspection of the land by train and then by a more detailed one on foot or by other slow means of travel. This latter was not always done. One of the first steps in the appraisal was to divide the lands into zones of value, i. e., so much of a continuous stretch of the carrier's land, as in the judgment of the appraiser, fell under similar influence from similar lands and hence might be said to be of substantially the same value. The Appraiser was permitted to co-operate with the representative of the carrier in laying out zones, but was not permitted to undertake further co-operation without special permissioon.

Various sorts of information with respect to the value of privately owned lands in the vicinity were then accumulated. Where it was thought that assessment values, affected by the ratio of assessments to true value reflected value, then assessment data was gathered. Sales of privately owned lands in the vicinity were always considered of prime importance and although the appraiser was not definitely instructed as to the territory from which the sales should be taken, or the number of years which they should cover, he was cautioned to secure all of the sales which could be had with a reasonable expenditure of time, and to make sure that the consideration shown by deeds was actual and the sale a normal one. The appraiser was further instructed, that after having familiarized himself in a general way with values, he should select from local residents, at least three witnesses, and obtain from each of them, out of the presence of the others, an opinion as to the zone. Where other reliable data was found unavailing, pertinent information as to such as rentals was required of the appraiser.

In determining the unit of value applicable to the zone, the appraiser was asked to give weight to that data which he felt was the most reliable and to fix the unit while actually in sight of the property, although the Valuation Attorneys always reserved the right to amend any figures fixed by field appraisers.

What has been described is the method which the appraisers were directed to follow. The application of the data to the area of a zone furnished the occasion for wide variations of opinions as to the same zone because of differences in viewpoint and experience of appraisers, who were almost universally men unacquainted with the territory in which they worked and always in some doubt, not only as to certain principles of application which will now be taken up, but to some extent as to the scope of their work or the actual meaning of present value of land. For example, it was said in their instructions that if the carrier land is specially adapted to railroad use, while the land with which it is compared is not, that is a similarity which should be given due consideration. It does not appear that any appraiser produced any tangible result under this particular instruction or ever reported any data on the value of special adaptability for railroad use or was he, in fact, really required to do that.

Terminal Lands.—The instructions seem to have been written with rural right-of-way largely in mind. It soon became apparent, however, that perhaps 75 per cent of the value was in areas of considerable size within the larger towns and cities, hence that such questions as (1) Whether when a right-of-way ran through the center of a block, rear lot values should be applied; (2) Whether a terminal area should be viewed from a subdivision or development standpoint and not only hypothetical streets cut out of it so as to give the same street accessibility as had the privately owned land from which values were taken, but whether amounts should also be deducted to cover paving, interest and other development expenses; (3) wether grading quantities which the carrier had placed upon land, so raising the same to the level of adjoining land were to be included in the land value or in the engineering estimate of cost of reproduction of structural property.

As indicating the conservatism of the appraisals of the commission and that present value determined by the same is a value based strictly upon the value for other than railroad purposes of privately owned land in the vicinity, it should be said that; back lot values were applied under circumstances as just pointed out; hypothetical streets were cut out of property so that the effect was to allow nothing

for the equivalent of about 25 per cent of the area of terminal lands; amounts were deducted from the unit applied to cover such expenses as interest, paving, etc., which theoretically would be incurred if the property were to be subdivided; grading quantities, where placed to raise the carrier's land up to the level of adjoining land, were deducted from the cost estimate of structural property and assumed to be included in the land value, even though the value of the carrier land for general urban building purposes would be greater because of the lesser costs for excavation if this grading material were not there; no allowance for special assessments is made in the estimate of cost of reproduction because it is said that the full value of such is included in the present value of the land. Sales of adjoining land are ordinarily considered as evidence of value only when they occur prior to date of valuation. A further influence on the side of conservatism in the appraisal of city property grows out of the fact that privately owned land on one side of a terminal tract is usually much lower in value than land so held on the other side of the tract.

This gives opportunity for very important differences in application of units of value to such areas. Although it would seem that where a city was of such size as would enable it to absorb the whole of the terminal area without particular affect on values the units applied to it should decline on a straight line from the side of high value to the side of low value. The appraisals of the commission are not so made but instead the influence of the value on the high side is carried but a limited way into the terminal area.

Classification by Ownership.—The results of the appraisal determined as above explained are served upon the carrier in the form of a land report, which shows the present value of land by the following classes: (1) Lands owned and used by the carrier for its purposes as a common carrier; (2) Lands used by the carrier for its purposes as such, but owned or leased by other common carriers; (3) Lands used by the carrier but owned by parties other than common carriers; (4) Lands owned by the carrier but used exclusively by another carrier; (5) Non-carrier lands; (6) Rights in public domain, the present value of which is set up at cost of the same to the carrier. These are largely made up of rights to occupy streets jointly with the public; (7) Rights in private lands, the present value of which is based on cost to the carrier except in some instances as water rights where value is estimated.

The Commission's Treatment of Present Value.—The commission took the position early in its common carrier valuation work, that the present value of land is limited to the acreage or square foot value of privately owned land in the vicinity held for other than railroad purposes and that the present cost of condemnation and damages, or of purchase as required to be reported by the act, could not be ascertained. Even if it could be the figure would not be of use because it was said to have been decided by the United States Supreme Court in the Minnesota rate cases—after the passage of the valuation act—that the present cost of acquisition of land does not measure the present value of it.

The first tentative valuations did not report the present cost of acquisition of land. One of the interested carriers brought a mandamus proceeding—intended to compel the finding and reporting of this fact as required by the act—which went to the United States Supreme Court where it was held that the commission should comply with the law. A force was immediately organized and soon the Commission after having determined upon certain underlying assumptions such as, that present rather than original severance conditions should govern, that no buildings should be assumed to be upon the land to be acquired, that no speculation should be entered into as to what land would be donated, that fair treatment under the right of emminent domain would obtain, that no amount should be included for interest and taxes during construction, had determined upon factors applicable to the base land figure which had already been determined and described as present value, which factors or multipliers varied by types of property, being lowest for city property of high value and highest for rural property of low value and when applied reflected an estimated present cost of acquisition. The incidental costs as right-of-way agent

salaries and expenses, recording fees, etc., were estimated from voluminous and reliable data on a basis of the per cent of purchase price. The result was that for an average railroad the present cost of acquisition of land was reported at about 60 per cent higher than the present value of the commission based on the acreage or square foot unit of value reflected upon the carrier land from privately owned property in the vicinity.

The first tentative valuations to state a single sum value for the whole of a railroad property were said by the commission to have been determined after a consideration among other things of the excess cost of the carrier's lands or in other words, the present cost of acquisition figure. While it is a mere guess as to what sort of a land figure actually was included in such single sum value, it is the common opinion that no weight was given to or was anything included over and above, the acreage or square foot value from adjoining property.

Amendment of 1922.—In June, 1922, the valuation act was amended so as to strike out the requirement that the commission find the cost of reproduction of land or the present cost of condemnation or purchase of the same. Following this amendment the commission, although it had almost completed the work, stopped it and in the tentative valuations which have been reported since that time the estimated present cost of carrier land has not been mentioned as one of the items considered in determining the value for the whole property. It will be apparent that the present value of land as now being determined not only may be but is sometimes less than the actual cost of the same since nothing is included for severance and other damages for which a carrier must pay nor the incidental expenses of acquisition which must be met. The commission has not disclosed how this present value is used in its value formula but it is commnoly thought that it is one of the sums which is added directly into the value figure.

Contemplated Legislation. — The question of how to determine the present value of lands used for railway purposes is not answered in the same way by the Federal Commission as it is by the carriers. The former, as explained above, think that such value is measured by the square foot or acreage value of adjoining lands while the railroads think that the figure is found by finding the market value or cost of acquiring on valuation date of the right-of-way in question or an equally suitable strip. There seems to be agreement, in view of the many decisions of the United States Supreme Court, that original cost is not the measure thereof. Now comes the Solicitor of the Bureau of Valuation in a brief written last January, mildly calling to attention that the Commission should consider whether or not the increase in the value of land has not been so great as to render a return based theron unjust to the public. Of similar import is a bill introduced in the Senate last February, which, among other things, provides that "The Commission shall not include any increase in the value of real estate as held by the carrier and which was unearned by the carrier." There has seemed to be an agreement that value is a judicial question but the fact that such a bill could be before the Congress with the support it has would lead one to think that even that is questioned by those holding more than radical views.

Perhaps the transportation act which made valuation, including land valuation, the basis for practically all regulation, made it inevitable that common carrier value should become a political issue. State railroad commissions are becoming increasingly active even to the actual appraisal of land in the field; only this morning press reports stated that certain so-called progressive senators, governors and other public officials were organizing a conference to be held in this city on May 25th and 26th to discuss railroad valuations and in that connection Senator La Follette is quoted as saying, "When the committee on transportation created by the progressives undertook its study of the railroad situation they were impressed by the fact that the key to most all of the transportation problems was in the valuation of the roads." At any rate, political considerations promise to be most important in conlusions with respect to valuation of railroad property including land and it follows that predictions as to the outcome are uncertain.

The Motor Bus and the Electric Railway

How Co-ordination May Be Brought About Outlined in Discussion at Recent Convention of American Electric Railway Association

By L. S. STORRS,
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The problem is divided into the three classes into which the traction utility, itself, automatically falls. Consider first the metropolitan area in which the main stem of the traction is the high speed line, either subway or elevated, with the distributing surface lines. These surface lines may or may not be operated by the general traction utility. The problem as to co-ordination is narrowed down to the question as to what is in the best interest of the numerous local centers as against what is of benefit to the metropolitan area as a whole.

The question of suburban and interurban routes is entirely different from the urban problem. The highways, which had been improved at the expense of the public, have made possible great speed, which, coupled with the flexibility of the motor stage, has been the controlling element in the development of the competitive motor.

Nor is this phase of the problem similar in different parts of the country. Climatic conditions and the relative level and open roads of the Pacific Coast make possible a form of stage operation entirely impossible in areas of more rigorous climate and hilly country.

In the cities throughout the land the transportation problem is necessarily one in which the general benefit of the community as a whole must prevail as against the particular interest of any individual or group.

Civic Side Should Outweigh All Others.—It is as essential for the growth and continued development of the cities that the civic side of public transportation should outweigh all others, as that the city should be properly zoned, and the various functions of the city group kept within proper territorial limits.

For this reason the traction utility is most distinctly monopolistic in character. No community can receive an efficient public service and one that is constantly equipped to expand with the increasing needs of a healthy civic growth that does not recognize this fundamental fact.

Any competition that tends to restrict the proper earning capacity of the general municipal transportation utility will render that utility incapable of performing its proper function.

There can be no question but that the utility management is the only one capable of unifying all transportation service in any city to the ultimate advantage of the entire community. The personnel has been trained to a thorough observation of the needs of the various portions of the community and experience has taught them the best method by which the service to each community may best be interwoven into the whole transportation fabric for the benefit of the whole system.

When charged with the obligation of adding to the existing rail facilities the mobile motor auxiliary, this group of experts certainly can do better work and accomplish more satisfactory results than any other.

In the ultimate analysis "public opinion" will dictate the method of operation and the means by which this desired co-ordination is to be accomplished. Public opinion is slow to recognize the actual economic principles of a utility problem.

The Problem of Competitive Service.—The great factor that rendered possible the marked advance in urban motor transportation was the necessary increase in the rate charged for the service rendered by the electric railways. With the ability of the independent bus operator to confine his activity to the area of greatest density, the high factor of loading has enabled him, generally, to keep his rates lower than has been possible on the electric railways, which must serve the entire community, with the varying load factor produced by service into territory of low population as well as the more densely populated areas. This, coupled with the natural prefer-

ence for the individual as compared with corporate methods, has made it almost impossible to bring about a complete co-ordination of service in any community.

The prime essential to the inauguration of any plan that would tend to bring these two agencies into a common effort to solve the increasingly difficult problem of urban transportation is the recognition that this new medium, even if operated by an independent owner, is really but a single unit of many that are required to provide the complete transportation requirements as a community, and as such must be placed in operation where the service rendered will be really necessary to the particular part of the community in which it is to be operated.

The great trouble in this instance is in confining the bus to such portion of the community; for it will, of necessity, be in a part of the city which has not reached the maximum density of population. Of course, the bus owner will much prefer to operate in areas where he will obtain a constant heavy load and where he can operate at a less rate of fare than the prevailing street car rates. The densely settled areas are always to be found along routes of public transportation which have been developed by the electric railways. Here, as always, the preference of the individual will be in conflict with the benefit of the community as a whole.

Another factor that works against the inauguration of a co-ordination of the two agencies is the reluctance the executive of the railway must have against establishing a service in an untried area, with the certainty that, once established, he must continue the service indefinitely, whereas, the independent can abandon the operation if it is found to be unprofitable.

Destructive Effects of Unfair Competition.—It is a comparatively easy matter to imagine a city where the electric railway and bus operations are thoroughly co-ordinated, where the electric railway performs the regular service over the rails which were laid as the city was growing, residence areas defined, and industries located with the houses of the workers in close proximity and the business portion of the city gathered around one or more convenient centers, in short, a city in which the electric railway facilities are ably prepared to care for the mass movement of the inhabitants, where the busses are confined to service in areas that have grown up in recent years, where there is an apparent need for transportation service which the utility has not been able to meet due to lack of funds to extend its facilities. Here the bus will meet an evident public need and should be operated.

But, assume that in the same city, or a similar one, the independent bus operator had been allowed to run in competition with the electric railway through the densely populated areas, unregulated and uncontrolled, and had taken so large an amount of the revenues that should have gone to the utility that the utility rate had been advanced above the bus rate in an effort to make the income provide enough to meet the necessary outgo. What would be the public reaction to a proposal to co-ordinate the service, make the bus supplemental to the electric railway and thus give a unified service to the entire community?

Theoretically, this is the desired outcome, but I contend the matter is merely one for academic discussion up to the point that either one or the other facility faces bankruptcy and, of course, it will be the utility with its obligations to render service throughout the entire city.

Public Opinion Must Bring True Co-ordination.—This is all leading to the contention that the necessary preliminary to any effort to co-ordinate these two agencies is a public opinion that will support legislation which recognizes the two agencies as merely different means of providing a convenient and needed public transportation service which must be unified in order that the various communities may have a thoroughly efficient transportation service at the lowest possible rate.

In any state where the legislative acts have been changed to recognize this situation it is relatively a much easier task to accomplish a co-ordinated public transportation service. In such states there are places outside of the city areas served by the independent operator should find sufficient inducement to provide service. The real co-ordination devolves upon the transportation utility and a full measure bus operation should be undertaken as rapidly as the need for serv-

ice is apparent and funds available to provide the equipment.

Under all other conditions we can talk all we please about co-ordinating these facilities, but can accomplish nothing until the public opinion is of a temper to accept the needed regulation.

There is no question but that this competition which we have all had to contend with has provided a very valuable spur to all engaged in the transportation utility. Coming as it did at a time of advancing costs the drain caused upon our revenues by this competition made it all but impossible to continue operations free from receiverships. It has been necessary to put into effect so many economies that the entire theory and system of electric railway methods bears but little resemblance to the common practice of a decade ago.

Gradually, but no less certainly, the transportation utility will adopt this newer form of vehicle for public service. The actual place of this agency in public service has as yet to be developed. There are, of course, many instances where its value is clearly apparent, but until each individual unit is operated as to bring in the maximum revenue and perform a service of the greatest advantage to the public the true function of the motor will not have been developed.

"Co-ordination" Does Not Mean Competition.—There is one question that must be answered and it is essential that the definition of this term "co-ordination" be thoroughly established so that there be no misunderstanding in the future. Do all parties have the same understanding as to what is to be co-ordinated? To all careful students of public transportation the idea of competition is repugnant. This method of diverting a portion of the public charge for transportation, from the agency that is constantly endeavoring to render a satisfactory service at the lowest possible cost, is merely the club really wielded by the public itself in an effort to obtain from the transportation agency, either a lower rate, or a slightly more convenient service than it is ultimately possible to obtain and in the long run the public of the community, as a whole, will suffer.

We cannot, therefore, contemplate any so-called co-ordination that would inject an intense competition between the electric car and the bus.

Operated as an auxiliary to the rail lines, the bus can perform a most useful function in the community. Its maximum value cannot, however, be determined until after a long period of actual use and careful experiment.

There are, of course, areas in many cities that have heretofore been without any convenient public transportation, in which even the independent bus operator has not ventured. In some instances by an abandonment of a portion of a rail route a more serviceable route can be established by motor. At certain periods of the day temporary bus routes, entirely impossible by rail, can be operated to the great convenience of a portion of the population. A continuance of service by bus may be possible where the cost of changes or repair of unprofitable rail lines would otherwise necessitate the complete abandonment of all service.

The public cannot escape a very distinct benefit from the present attitude of both the executives of the transportation utility and the manufacturers of the motor vehicle in the mutual efforts to find a common ground for co-ordinating all means of transportation.

A long road has been traveled by each in the past few years. On the railway side, from the stand that the motor was of absolutely no public use except as a club over the head of the utility. On the part of the motor vehicle manufacturers, that the value of the railway was ended and this newer vehicle was to be substituted for public transportation.

Forestry Cooperation Between Federal and State Governments.—Constructive cooperation between the federal government and the states was urged by the executive board of the American Engineering Council at its closing session in Rochester, N. Y., on Oct. 13. The board adopted a resolution, prepared by its reforestation committee, recommending an annual appropriation of $2,000,000 for the purchase, under the Weeks law, of forest lands on the water sheds of navigable rivers.

Development of Railroad Motor Car

Present Practice and Requirements for Gasoline and Gasoline-electric Driven Cars on Rails Discussed in Appendix to Report of Special Committee of U. S. Chamber of Commerce

Railroad men generally have long recognized the need of an economical railroad motor car for light traffic on branch and short line operations. Various types have been under observation for more than a quarter of a century but it has only been within the past few years that a practical vehicle has appeared possible of attainment.

A review of the various models indicates three stages in the development of the art:

First Stage.—In 1897 the effort to adapt to railroad practice a steam car; followed by the use of compressed air and oil burning units. All of these were heavy cars with engines of small boiler capacity, small driving wheels but with uncomfortable riding qualities. Both initial and operating costs were so high as to result in a gradual abandonment of the cars after suitable trials by American railroads, although several cars of these various types were in successful operation on French and English lines in 1903.

In 1901 the Minister of Railroads of Austria ordered an "automobile car" operated by an oil burning engine. The unit proved quite satisfactory and in consequence both foreign and American motor manufacturers turned to gasoline engines, sometimes in combination with electric power (gasoline-electric drive).

Many of these cars were gradually put into use by some of the railroads in this and foreign countries. A number are still in use. However, these units were not satisfactory, consequently their manufacture was discontinued.

Second Stage—Motor Practice.—Meanwhile motor truck manufacturers improved design by reducing weight per brake horsepower, and increasing the efficeincy of the engines.

The next development was to convert the motor truck into a railroad motor car by substituting flanged wheels for rubber tires. The possibility of economy through weight reduction led to a trial of a number of these units. Although comparatively economical, further experimental work was neecssary in the endeavor to overcome bad riding qualities.

Third Stage—Combined Practice—Present Development.—This stage of development finds manufacturers engaged in an effort to combine locomotive and gasoline engine practice. Cars that carry baggage and passengers are already in service. Equipped with 4-wheel trucks front and rear, these units are in many cases satisfactorily meeting railroad requirements and, at the same time, through following motor vehicle engineering practice, are making lower operating costs possible.

Thus far, the development in this country has been almost exclusively in the direction of handling light passenger traffic. There are experiments under way, however, leading to the accomplishment of moving light freight more efficiently and economically through the use of demountable bodies.

The Development Abroad.—In France there has been developed what is known as a locotracteur, a gasoline engine capable of hauling light freight trains. One of these units has been in successful operation for 10 months and a leading French railroad has ordered six additional units.

Seven private Swedish railroads are now using cars with engines capable of developing from 75 to 180 horsepower, with a dead weight of 16 tons and capacity of 58 passengers. Italy has five or six cars of the same type. In both cases the equipment was manufactured in Germany, where it is reported decided advances have been made in this field.

A Railroad Official's Deductions.—The subject of the railroad motor car from the viewpoint of the management of one of our large railroads is summed up by its operating vice-president as follows:

"The gasoline motor car seems to have its field principally at points where it is necessary to provide frequent service for a small number of people, such as interurban trolley car service, as it is possibly the least

expensive method of providing this kind of facility. In order to secure its maximum economy, however, it is necessary that it entirely supplant the steam service for this purpose.

"There seem to be very few places on our road where these conditions exist, it being necessary to provide infrequent service for a larger number of people rather than frequent service for a comparatively small number of people, and the steam train with two or three cars thus lends itself better for this class of service. Furthermore, the service conditions on most of our branches are such as to necessitate a certain amount of shifting and other miscellaneous work which can be performed to good advantage by the steam locomotive of the passenger train, but cannot be handled to advantage by a self contained motor car unless the motor car is built of sufficient power to act as a switch engine.

"The service on our branches involves the handling of baggage, express and mail, as well as passengers, and we have yet to see that this could be performed properly by self-contained motor cars for the same expense—taking everything into consideration—as it can be handled by a train consisting of a light steam locomotive, combined car and coach, due to the figure at which such steam equipment suitable for the service stands on our books."

Field of the Railroad Motor Car.—Broadly speaking, the greatest field for this type of equipment is principally at points where it is necessary to provide frequent service for a small number of people. The service reaches its maximum economy where it entirely supplants the steam train, but it can and does perform a major service in the case of many light carrier lines by reducing operating losses to a minmum.

The places where the railroad motor car can be used to the best advantage are:

(a) Short line railroads.
(b) Branch lines of main systems.
(c) Local main line operations on railroads where through train service is not heavy enough to require full time steam train schedules.

In each case where the use of the car has been considered, it has been found necessary to make a thorough analysis of local conditions, with special reference to the following factors:

(1) Number of passengers to be carried.
(2) Amount of baggage, express, mail, and, in certain cases, light freight to be hauled.
(3) Necessary for supplemental steam equipment.
(4) Availability of such steam equipment. (Most of our railroads have on hand light equipment which, dependent upon the system of accounting used, has already been partially or wholly amortized.)
(5) Number of daily trips to be made. The saving in labor in such cases will depend more upon a full utilization of the train crew's time, rather than upon the mileage covered.
(6) Need for personnel experienced in the operation of motor vehicles.

With these limiting conditions in mind, the first function of this vehicle would be to establish a more frequent and cleaner service at an operating cost of from 25 to 50 per cent less to the railroad than the cost of steam service.

Steam Trains Replaced by Railroad Motor Cars.—The American Short Line Railway Association has records showing that 170 motor cars are in use on 11 lines, of which 21 are trunk and the remainder short lines. These records also show that the approximate mileage now being covered by motor cars is 7,041, and that about 170 steam trains have been replaced.

According to the association, "while a great deal of money has been expended in experimental work, part of it misdirected, the actual investment in serviceable motor cars (on rails) today is probably not in excess of $2,500,000. The steam train investment necessary to provide the same service would probably approximate $8,000,000 to $10,000,000."

Freight Service Requirements.—In general a survey of the use of existing facilities indicates that short line railroads have, in some cases, used railroad motor cars to entirely replace passenger steam service, while the large railroad systems have used these cars for what amounts to practically an interurban operation. Since the fullest measure of economy cannot be obtained until the railroad

motor car can replace all steam equipment in this service, research work to this end is now being undertaken.

Development of these cars for the carriage of freight would have an even more marked effect on rail transportation costs, as it would not only eliminate the necessity for water, coal and roundhouse facilities now required, but would also lower the cost of maintenance of way charge.

Obstacles to overcome in this phase of the development of the equipment, are: first, that in order to obtain lower operating costs; lighter construction is necessary; and second, that legal train crew requirements, when using multiple units, prevent any great saving in labor costs, even though other operating costs are less than on steam equipment.

Principal Physical Requirements.—A summary of conclusions reached by steam and motor experts closely identified with the development of these vehicles indicates that while a wide variety of bodies will be needed, three types of chasses will generally meet most railroad requirements, which may be classified as follows:

Light or small type—Seating capacity, 32 people. No baggage space. Engine capable of generating 35 h. p. with maximum speed for short distances of about 45 miles per hour. In general this would be simply a converted motor truck with six wheels.

Medium type—Seating capacity of 35 people. Six ft. by 9 ft. baggage space with bulkheads arranged for convenient interchange as between passenger and baggage space. Engine capable of generating 50 h. p. This size may or may not require eight wheels arranged in two 4-wheel trucks.

Heavy or large type—Seating capacity of 50-70 people. Baggage and lavatory facilities, and bulkheads arranged for convenient shifting of space. Engine capable of generating at least 120 h. p. Running gear of two 4-wheel trucks.

Light Construction Essential.—In each case the gross weight per brake horsepower should be as low as is consistent with safety and economy.

Standardization of units is desirable wherever possible.

In some of the more recent developments of large units, engines have been employed generating horsepower far in excess of the specifications mentioned and with a type of construction capable of pulling one or more trailers. Such units have just recently been installed on some railroads.

Research work is in progress on designs, which should eliminate the obstacles encountered in earlier development.

Creosoted Timber Coaling Stations

During the past few years the Nashville, Chattanooga & St. Louis Ry. has erected four mechanical coaling stations of creosoted timber. We are indebted to an article by Hunter McDonald, Chief Engineer, N., C. & St. L. Ry., in Wood Preserving News, for the following details:

Southern pine was used, treated by the full cell process with a final retention of 16 lbs. of A. R. E. A. Grade 1 creosote oil per cubic foot.

Framing the timbers prior to treatment necessitated the preparation of detailed plans for each piece which was correctly sized at mill. Bolt holes were bored before the timber was treated. No trouble was experienced during erection of the structures because of warping or twisting of the various pieces while being treated.

The rafters, roof boards, drop siding above the coal bins and studs above the bin plates are the only parts of the structures that were not constructed of creosoted timber.

Approximately 90,000 bd. ft. of creosoted timber was used for each coaling station, the maximum size of stick being 16 in. by 18 in., and the 12 in. by 12 in. posts were reinforced by 6 in. by 12 in. pads securely bolted to the 12 in. by 12 in. timbers. Bin ties, or waleing, used, varied in size from 12 in. by 12 in. to 8 in. by 10 in. Planking for the coal bins is 2 in. by 12 in., and for the sand bin 2 in. by 10 in., dressed and matched. Length of the timbers required varied from 10 ft. to a maximum of 38 ft. Inasmuch as the 2 in. by 12 in. bin planking would not withstand the continual wear of the sliding mass of coal, the interior and floor of the bins were lined with 2 in. untreated beech, that on the walls being placed on diagonal so as to give the additional stiffness to the structure and at the same time act as a wind bracing.

The oldest of these stations has been in continuous service since 1918.

Common Labor in Railway Construction and Maintenance

An Interesting Discussion of Three Classes of American Labor Given in The Cornell Civil Engineer

By WILLIAM BEAHAN
First Assistant Engineer, New York Central R. R.

The purpose is to write of common labor out of personal observation and the experience of being in charge of it. The field of vision is narrowed by personal life. This is not an effort to generalize, but an attempt to give the human touch. It is not a moving picture but a series of "close-ups."

Having stated the limitations of this paper, it is fair to say that what is written down here is not second-hand.

The Spanish-American Laborer.—Why is a Spanish-American? When our Anglo-Saxon ancestors came here they drove back the Indians. As a race, Saxons, or indeed North Europeans do not intermarry with the Indian. But the races from Southern Europe settled in all this hemisphere south of the Rio Grande River. The Latin races do and did intermarry with the Indian. There is no Mexican, no Peruvian, no Chileno. He is a mongrel of Latin and Indian—a fractional European. It makes a great difference whether he is now one-sixteenth or fifteen-sixteenths Indian. And today, the infusion he is now getting of white blood is of a poor quality in the main. The term Spanish-American must be very elastic. Often it is not Spanish in foundation, but Portuguese, as in Brazil. The Indian tribes were not the same. The Peruvian Indians were small in stature while the Chileno Indians—the Aracauicin—is very large and strong and brave.

But the Spanish-Americans now in the United States and steadily coming are all from Mexico. Those Pucuans seem a mixed race and among their better classes a goodly number of Aztecs—a race on this continent prior to our Indians. The Aztec is lighter in color and of greater intelligence. We built the west end of the Texas and Pacific Railroad in the early '80s largely with Mexicans. They are small men. They are timid and not aggressive. Singly they are never dangerous nor disorderly. Our company guide, Pat Dovling, estimated that one man of the kind of men on our engineer parties could whip six Apache Indians or thirty Mexicans. These guides knew such things perfectly. That year the Apaches were on the war path in that country. In the early '90s in Chile, there were five of us "Yankees" kept five hundred Chileans quiet and paid them off in the mountains far from civilization all day one Sunday and they were pretty drunk. They were our employes—and inferior races respect white men who are over them.

Our Mexicans are not strong enough to do what an Irishman or Polack can do. He was not fed well when young. He eats little now. He dresses too thinly and does not keep storms away from his body. He has to lay off some days. He has many impediments. He brings along his wife and children, his dog and chickens, and any household goods he owns. He is not a single man often. He is peaceable, obedient, touchful and works the best he can. He is not a full man.

The American Negro.—Today the American Negro is a mongrel race and the White blood he has in recent years taken into his veins is far from the best. Men most used to handling negroes prefer those most black. If we consider our negro to be a child in mind with not a little of his African superstition and being "scared" of "hants," we will approach him from the right angle to get on with him. Singly, he is timid, but not cowardly. The mule and the negro have much in common. Each are mongrels. Each has been maltreated. Personally, I respect each for what he has been. The mule built all our transcontinental railroads. May one who has suffered much with him there pause to lay a garland on his grave. And on a modest headstone in legible lines I would write: "Hic Jacet A

Mule." Without pride of ancestry or hope of posterity he "carried on."

The African in his habitat is of good size and strong. The American Negro is not inferior to the white man physically. His back is especially strong, and he is excellent labor handling heavy material. He has a good nature. He is not vindictive, i black. He eats well—thus being far superior to the Italian. He works steadily until he feels sick. He likes good clothes in bright colors. He is not especially bad about drink. He is a knife fighter—using a razor ("razzer") but respects a white man who is worthy. He is on the whole peaceable. He will steal food when hungry. He is not a thief. We brought 1,500 from the South in 1917 and they lived all summer on the right of way in cars and cabins along the line of the New York Central Railroad west of Buffalo. Our neighbors never once complained of their thieving or disorder. These were the first negroes we ever had. Our white men had gone back to Europe to fight. One of our oldest and best supervisors of track said to me when I turned over to him one-half of the first coach of seventy-five which I had handpicked in Louisville, Ky.: "These men are large and strong, they eat, they are good-natured and they talk my language. I can get along with them."

You must consider the American Negro as a child. Have patience. Explain to him. Take care of him when sick. Don't let him overeat or wear insufficient clothes. Don't let men of another race abuse or frighten him. You will hear much about "making a negro keep his place." If you keep your place he will keep his. If he does not you let that negro go. You will lose but few. Don't use bad language to a Negro, a Mexican or a Hobo. You can't afford it. Never swear at a man whom you have the right to discharge. It is cowardly. Never lay hands on either except to keep order—and do that before he can start. These negroes are our best common labor in this country today after the white American and the northern European. They require our oldest foremen and these must speak English without any foreign accent. For such men are what the negroes have had over them in the South.

The "Bo" As a Laborer.—I now come to speak of our "Casual Workers." I have heard them aptly called "Our Marginal Group." A quarter of a century ago we spoke of him in our far northwest as a "Bo". Some later we said "Hobo." My lexicon says the term is a colloquial from the western United States—origin unknown. He is, as a rule, American born. He is a white man. How does he happen? At Winona, Minnesota, one winter, the cold weather had come on early and suddenly. They got caught north when they meant to be south. We were feeding a good many as they journeyed. One excellent and efficient woman said to one of these men as he was eating in her kitchen: "You are an able-bodied, intelligent man of not very bad habits. You have no money, no food and no overcoat in Minnesota in winter. Won't you tell me what is the matter?" "Well," he replied, "I've been up against it and I fell back—and that's all there is to it." A man loses his wife or his sweetheart or he is beaten out of what he thinks was his share of his father's estate, or his partner gets the best of him, or he gets sick and loses heart, or, last, but not least, he loses his position through drink—and there is our Hobo. Misfits, black sheep, unlucky, often but half education, boyish, reckless wanderlust or what not —Driftwood on life's stream. "Ye are all brothers"—says the Master. As you and I are able-bodied and able-minded it is up to us to be keepers of the Hobo. Crying over him won't do at all. He is "all right" always, if you let him tell it. But his other brothers and the world in general has gone to the dogs. He is not hopeless. He often reforms. Of several hundred Hobos on a work lasting a year or so you can get one-third of them to stay it out. Another one-fourth will stay quite a while. Physically, he is above the average of us in strength except when drink or scanty food has pulled him down temporarily. Until the I. W. W. got abroad in this land, I could not say he was particularly adverse to a reasonable amount of work. You can teach him anything about the work. If you have a gang of fifty to work, you are lucky if there be not more than one man in it who is smarter than you are. The Hobo will take care of himself if you will keep great temptation out of his way. No child, he. His foreman must know his business, but the gang fore-

man need not be especially old. The general foreman must be at least middle aged and strong enough to command their respect.

A "Bo" Is Not a Tramp.—Lest I be misunderstood let me say that a Hobo and a tramp are not the same, although a man may cease to be of one of these classes and join the other class. A Hobo works casually—a tramp never. A hobo stays on the job until he has a hobo "stake." Each hobo has a different sum as this goal probably. Some used to call two dollars a stake—fifteen is a nearer figure. Having bought fair clothing from the commisary and with his own stake in his pocket he washes up, shaves and possibly bathes—"and hits the trail." He heads for a better climate and a place where pay is higher. The Associated Press never had anything on our hobo in the way of ability to know what is going on in industry or public work. He is posted. Start work requiring special experience in your common labor at extra good pay and in sixty days you will have the most of the men in America who do that kind of work. It was our belief when doing compressed air excavation (pneumatic) work that it was impossible to carry though a pressure job in the United States without Jere Fruin showing up. "Now we can finish," was the word sent round to our fellow contractors. A goodly number of these men start the wheat harvest in Northern Texas and follow it with its season well up into Canada. Others worked in the Northern lumber camps formerly, then rafted the logs south to mills where they worked. The hobo is strong, intelligent, capable and very great in emergencies. In a "washout" or a "burn-out" or a snow blockade he has no equal. He will follow a leader through a hell. But he is turbulent. He will strike, sometimes through pure meanness, and sometimes through sheer deviltry. And he is bad and destructive when once started. Know your business, treat him right, make him work and don't fear for your skin and you'll get on. Be square, tell him straight and sail in just when trouble comes and the hobo is your friend and brother and will not strike. At least, that is my experience. Still, he is harder to manage than Mexicans or Negroes. But he is worth more to you. He is the bane of an incompetent boss. As he is our misfit, he is here forever. The eighteenth amendment has lessened his numbers perceptibly.

I have frankly said many times that when the hobo shall pass away as a class, I wanted to be planted under the daisies. Life on our work would be dreary and humdrum without him. He is human nature personified. He is a child of our civilization. God must love him, as he makes so many of him. He may be down, but he is never out, of sorts. I was walking on the highway just east of Erie, Pa., last fall. Our railroad tracks were parallel to this and a quarter mile north. The north wind was brisk, the sun warm. I spied a man sitting on the sunny side of the cut bank. I feared he might be sick or struck by an auto. I stopped and looked inquiringly as though to ask what was up and could I help him. He saw that I noticed he was "reorganizing" his socks—that, is turning them over so the worn out heel would be in the instep and so ease a blistered heel by woven wool—a common makeshift. We mutually nodded and smiled. Said he, "It's a great life if you don't weaken." No other word was spoken. We both laughed. I passed on. He had spoken in a phrase his whole philosophy of life. And he won't weaken.

Shakespeare, as you know, speaks of the "retort courteous." The best specimen I ever met of that literary quality was from my friend Sullivan at the Cascade Tunnel of the Great Northern Railway. We had four hundred hobos there. When you work men eight hours every day for three or four months in underground work they need a vacation. We then passed them to Seattle and back with ten days vacation and kept their jobs for them. Sullivan and his partner had quit and were waiting at our station for a train when I chanced to come in. He struck me for passes. I explained that under the rule they were not entitled to passes, as he knew very well. He had been drinking and was Irish. Therefore, he would resort to the blarney of his race. "Superintendent, they've tould me you're a koind hearted gintleman." I stopped him with—"That's all right, Sullivan, but I'll not give you a pass." Looking at me in an injured way, placing one hand on his heart and sweeping the floor with hat as he bowed in a Chesterfieldian manner, he said: "So then Oi'm misinformed, am I?"

Pavement Within Street Railway Area

Abstract of Paper Presented Nov. 16 at Annual Meeting of National Municipal League

By R. C. CRAM,
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It will be conceded that the proper administration of pavement within the railroad area is contingent upon the proper co-ordination of two distinct structures, the track structure and the pavement structure.

Co-ordination of Track and Pavement.—That such a co-ordination may obtain, it is necessary that there be a clear understanding of the functions of the track structure is primarily that of furnishing a means for the support and passage of railway cars. In this respect the street railway track does not differ from the steam railroad track. In minor respects it may differ, but the principal difference is one of location rather than of structure. The factor of location, generally in streets, imposes several requirements which the steam railroad track does not have to meet, the principal one of which is that of adaptability to installation of pavements.

The function of the pavement, as a structure, is primarily that of furnishing a means for the support and passage of vehicular traffic. A pavement is a pavement no matter where located and its location ordinarily has but little influence upon the design of the pavement structure, excepting when the location happens to be within the confines of, or adjacent to a track structure.

It is only when the factor of location meets in a combined track and pavement structure that we have any unusual problems arising as to what should be the nature of not only the combined structure, but also of the individual parts which are so combined.

The track naturally is an elastic structure and when it is to be used in streets which contain a pavement structure, its elastic qualities require greater control but it is believed that such control should not be carried to the extent of attempting to provide an absolutely rigid structure. Sufficient rigidity should be provided, however, to prevent movement which will be detrimental to the pavement structure.

The pavement structure should be one which will not be unduly influenced by slight vibratory movements and means for preventing the element of water from damaging either the pavement or the track should be provided.

The most critical attention to details of design and inspection of installation of both track and pavement structure are essential in order to secure the desired combination structure. This extends to the same consideration of the details of the pavement structure for the entire street surface between curb lines and the railroad streets and pavements should be designed specifically for the railroad traffic. The American Electric Railway Association and the American Society for Municipal Improvements have jointly formulated a specification for tracks in paved streets, which should be of great assistance in securing proper track and track pavements.

Cost of Maintaining Pavements in Tracks.—In the several conferences between municipal and railway engineers on the subject of track pavement which have more or less recently been had, and in certain articles recently appearing in the technical press, there has been an insistence upon the part of municipal representatives that it costs more to maintain pavements in railroad streets than in non-railroad streets.

Certain data bearing upon such maintenance costs as obtaining in Brooklyn, N. Y., have been quite widely quoted and Mr. G. W. Tillson makes the following statement of Brooklyn costs in "Engineers and Engineering," published by the Engineers' club of Philadelphia—"During the years of 1913 to 1918 inclusive the cost of repairs to asphalt pavements in Brooklyn, N. Y., on car track streets in the areas outside of the railroad area, averaged $0.039 while on street without car tracks it was $0.022," per sq. yd.

It has interested the writer to examine the records of the railroad companies in Brooklyn with the view of determining what their costs for paving maintenance may have been as compared with the city costs just quoted.

For a period of about 10 years the engineers of the companies have kept a careful record of the maintenance cost of tracks and the following statistics are available:

The railroad companies maintain approximately 2,200,000 sq. yd. of pavements of all kinds in the Boroughs of Brooklyn and Queens. Of this total, 261,000 sq. yd. are paved with asphalt, principally in the 2 ft. strip adjacent to the outer rails but with a considerable portion within the rails as well. The larger part of this asphalt area in adjacent to tracks whose average age is about 17 years and whose maximum age is 29 years.

But the principal pavements between the rails are block pavement, usually granite, with some wood block, belgian and slag block, brick and even cobble stones. Approximately 1,500,000 sq. yd. of these block pavements are on a concrete base.

Railroad Costs of Pavement Maintenance.—During the years 1915 to 1918, the average annual cost for maintenance of these pavements for wear only (not including the repairs or repavement made following track work of any kind) was $102,972.00 or $0.047 per sq. yd. yearly. This unit covers all kinds of track and pavement and compares very favorably with that quoted by Mr. Tillson for asphalt only, being but $0.008 greater. Mr. Tillson's units are also subject to several interpretations. He notes a greater maintenance unit cost of $0.017 per sq. yd. for railroad streets than for non-railroad streets but it will be seen that the railroad unit cost above given is nearly the same as the city cost for railroad streets. The railroad costs are principally for areas paved with block pavements which are more costly to maintain than asphalt.

Meanwhile it should be borne in mind that railroad streets are generally important arteries and that a much greater pavement wear must be expected not only on the railroad area but also outside thereof, on such streets. It is by no means scientific simply to compare costs of maintenance of pavements on railroad streets with those for non-railroad streets without considering traffic and Mr. Tillson himself has said that the figures he quoted prove nothing but he believed they are indicative. They certainly are indicative of the probability that pavement maintenance on railroad streets is no more costly within than without the railroad areas, taken as a whole, and probably if taken in proportion to traffic carried the annual maintenance may be less than that on non-railroad streets. The rails certainly have prevented a great deal of wear by relieving the pavement through transference of a large part of the loads to the rails.

In 116 miles of the more modern track, built in Brooklyn since 1907, for which we have a very good record of paving maintenance costs covering tracks varying in age from 1 to 12 years and having an average age of 5 years taking the average of the expenditures for the years 1915 to 1918 inclusive we find unit expense of $0.031 per sq. yd. per year for the 4 years covered. This unit is slightly less than the city area unit of $0.039.

Again we find, to bring in the influence of the high costs of all items since 1917, down to Jan. 1, 1923, that the pavement in 160 miles of track varying in age from 1 to 16 years and having an average age of 8 years, has a unit expense of $0.041 per sq. yd. per year. This unit will be seen to compare most favorably with the city area unit of $0.039 for the period from 1913 to 1918 which was practically as yet uninfluenced by war-time and post-war costs which have prevailed since 1918.

Conclusions.—The administration of pavements by the railways, where required by existing statutes, requires expenditures for operations which do not form a part of the transportation service which the railways are primarily intended to provide. The installation and maintenance of pavements do not benefit the car rider.

Since the car rider is the one using the street, he should not be required to pay for pavements to any greater extent than is required of passengers in other vehicles which use the street.

There is no longer any good reason why a railway should pay for installation of original pavements or for complete repavements because the presence of tracks has nothing to do with the question of the need for street pavements.

The only possible requirement as to railway pavements may be one relating to the extent the railways, through operation of cars, cause any deterioration in the pavement and this should be limited strictly to repairs needed in consequence of the existence and use of the tracks.

Construction News of the Railways

Grade Crossing Elimination at Scranton

Plans for the elimination within the city limits of Scranton, Pa., of grade crossings of the Delaware & Hudson R. R. Co. are being prepared. It is estimated the project will cost $1,000,000. The plans are to call for a number of changes in street locations and the erection of a long steel trestle over part of the city. The city and company will share the cost, although the county and state will be asked to bear a portion of the expense.

New Interurban Line at Houston, Tex.

Promotion work is underway for the Seaboard Electric Ry. Co., which proposes the construction of an interurban line along the west side of the ship channel to Seabrook, Tex. The line would be about 34 miles long. J. H. Thompson, 318 Carter Bldg., Houston, Tex., is interested.

St. Paul Union Station Financing

Issuance of $15,000,000 bonds by the St. Paul Union Depot company to refund existing indebtedness and finance the completion of the new passenger terminal in St. Paul has been approved by the Interstate Commerce Commission.

Double Tracking by Southern Ry.

Enlargement of the railroad yards at Asheville, N. C. and Knoxville, and construction of a double track between Asheville and Leadville, Tenn., involving an expenditure of several million dollars are contained in the $25,000,000 program of expansion planned by the Southern Railway. A survey is being made of the French Broad line between Asheville and Leadville, looking to the construction of a double track line between these two points. A survey of this section was made about two years ago and railroad officials recently ordered a re-check. Leadville is about 19 miles east of Morristown.

Double Tracking by Southern Ry.

Final plans are reported to have been adopted by the Southern Railway for a double track from Morristown, Tenn., to Asheville. The work includes a cutoff leading from Deep Ford bridge up through the Fork farm via French Broad River to Bridgeport.

Santa Fe Improvements for 1924

The Atchison, Topeka & Santa Fe Ry. is reported to have plans under consideration for adding $22,000,000 worth of new rolling stock next year and expending $70,000,000 for improvements throughout the system, it is understood this work will include $6,000,000 for second track and a $5,000,000 bridge across the Mississippi River at Fort Madison, Ia.

New Rail Line for North Dakota

The Red River Valley Ry., incorporated in 1914, has applied to the North Dakota Railroad Commission for permission to issue $5,000,000 of stock. The company proposes the construction of a new line between Grand Forks and Fargo, N. D. The incorporators are said to include W. H. Graves of Minneapolis, R. A. Hamilton of Milwaukee and C. M. Drew of Minneapolis.

Grade Crossing Separation at Lansing, Mich.

A tentative plan to eliminate grade crossings in Lansing, Mich., by raising the grade of the Grand Trunk Ry. tracks about 8 ft. and depressing Washington Ave. and Cedar St., has been agreed upon at a meeting of representatives of railroads operating in the city, and Mayor Alfred H. Doughty and Otto Eckert, city engineer.

Y. & M. V. R. R. to Spend $500,000 at Baton Rouge

The Yazoo & Mississippi Valley R. R. is to spend $500,000 for a new freight house and passenger station at Baton Rouge, La.

New Interurban in Texas

Surveys are underway for a proposed interurban line from Terrell to Tyler, Tex. Two routes are being surveyed, one by way of Wills Point to Myrtle Springs and Canton, the other by way of College Mound to Myrtle Springs, and thence to Tyler.

Six-Mile Railway Extension in Indiana

The Evansville, Indianapolis & Terre Haute Ry. asked for Interstate Commerce Commission approval for a 6-mile extension from Oakland City, Ind., into Pike County.

$100,000,000 New York Central Project at New York City

At a hearing held Dec. 10, by the Transit Commission and the Public Service Commission it was stated that the New York Central R. R. plan to solve the west side problem by running its freight tracks on an elevated railroad structure will eliminate 106 grade crossings between St. John's Park and Spuyten Duyvil. The complete plan calls for an expenditure of about $100,000,000 and includes changes in the railroad yards, the building of new warehouses and the construction of a spur under West End Ave. from 60th to 70th St.

$1,000,000 Improvement of Pittsburgh Railways

The receivers of the Pittsburgh Ry. Co., Pittsburgh, Pa., have been authorized to expend $1,000,000 for improvements.

S. P. Taking Bids on Natron Cutoff Work

The Southern Pacific R. R., according to reports is to open bids on Dec. 21, at its San Francisco office, on two additional units of construction on the Klamath Falls-Eugene line known as the Natron cutoff. The units are a 25-mile stretch in Klamath county and a stretch of 7 miles from the end of the first unit over the top of the Cascades and includes one of the long tunnels.

New Railroad Construction in Oregon

The Oregon-Washington Railroad & Navigation Co., has made former application to the Interstate Commerce Commission for permission to construct an extension from Crane to Burns, Ore., 32 miles, in order to be ready for movement of timber from the Malheur national forest, when the railroad from Burns into the forest is ready. Since the branch line from Malheur Junction to Crane is connected with the Oregon Short Line property, that company will handle the construction and operation. Originally, however, the line was constructed and now is owned by the O.-W. R. & N. This necessitated the O.-W. to make the application. An additional 50 to 60 miles of rail line will connect the branch line at Crane with the Malheur forest reserve timber at Seneca. This line will be constructed by Fred Herrick, purchaser of the timber.

Northern Pacific Has $57,000,000 Improvement Plan

The Northern Pacific Ry. is stated to have a $57,000,000 improvement program planned for the next three years. Among the work proposed is the following: An alternate low grade main line from Killdeer, N. D., to Newton, Mont., 80 miles in length; second main tracks from Little Falls to Philbrook, Minn., 80 miles in length; Eldridge to Windsor, N. D., 9 miles; Laurel to Park City, Mont.; Mission to Livingston, Mont., 5.6 miles; Superior to Anton, Wis., 7.4 miles; Pasco to Ainsworth Junction, Wash., 2 miles, and Great Northern crossing to Austin, Mont., 10 miles. Additional yard tracks proposed include those for the Yellowstone division, Glendive yards, Forsyth yard, Pasco division, Pasco yard, Kootenai yard, new yard at Everett, Wash.; coach yard, St. Paul and classification yard, Jamestown, N. D. Replacement and reinforcement of bridges and turntables, for the years 1924, 1925 and 1926, are estimated to cost, respectively, $1,025,000, $1,300,000 and $1,560,000. The three-year program for grade separation work is estimated at $1,550,000. It is proposed to build new storehouses at Duluth, Staples, Dilworth and Billings; new car shops at Mississippi St., St. Paul, and at Glendive, Mont. A new power plant is planned for the Como shops, St. Paul, and others for Brainerd, Mandan and Missoula. Commissary buildings and equipment are planned for Staples, Minn., and Laurel, Mont., and a new boiler and tank shop for Livingston, Mont. The total of estimates for new passenger stations and improvements to existing stations during the three years is estimated at $750,000.

Toronto Street Railway to Spend $1,250,000

The Toronto Transportation Co., Toronto, Ont., proposes extensions in York Township to cost $1,250,000.

New Line in Texas

Construction of a new railroad from Sam Fordyce to Rio Grande City, a distance of 22 miles, is provided for in a contract whereby the Rio Grande & Northern R. R. acquires supplies and materials assembled by the War Department at Sam Fordyce in 1917 for construction of a military road that was never built.

Subway Proposed for 6th Ave., New York

A plan for the removal of the 6th Ave. elevated and the construction of a subway along its route from the Battery to 59th St. to connect with the new Washington Heights subway was submitted Dec. 10 to the Board of Estimate of New York City by Borough President Julius Miller. The entire cost of the undertaking would be borne by the property owners through assessment. The cost of removing the 6th Ave. elevated railway through condemnation proceedings is estimated at $5,178,973, and the cost of constructing a 4-track subway along that route is estimated at $20,000,000.

New Railroad for Johnstown, Pa.

Officials of the Carolina plant of the Bethlehem Steel Co. have applied to the State Public Service Commission for a certificate of public convenience for the Conemaugh & Blacklick R. R.

Tunnel Contract Let by Southern Pacific

The Southern Pacific Ry. has awarded a $400,000 contract to the Utah Construction Co., for tunnel work in the Sierra Nevada mountains.

K. C. Southern to Spend $1,000,000 in Shreveport, La.

The Kansas City Southern R. R. will expend about $1,000,000 for the construction of viaducts and other improvements at Shreveport, La.

Branch Railroad to Wellington, Wyo., Oil Fields

The Colorado & Southern Ry. and the Union Pacific Ry. are reported planning the construction of spur lines into the Wellington, Wyo., oil field. The latter road has applied to the Interstate Commerce Commission for a permit to build an 18-mile line from Fort Collins and the C. & S. proposes a 7-mile line from Wellington.

Santa Fe Extension to Los Angeles Harbor

The Atchison, Topeka & Santa Fe R. R. extension from Los Angeles to Los Angeles harbor, a distance of 12 miles, will be begun shortly, approval having been granted by the California railroad commission. The cost is estimated at $3,000,000.

Industrial Notes

The Smith Engineering Works, of Milwaukee, Wis., manufacturers of rock, ore and gravel handling machinery, and Telsmith Crushers, has opened a branch office in New York City, in charge of Donald D. Barnes, formerly district manager in Chicago. The address of this office is Room 479, 50 Church St. Telephone number is Cortlandt 0180. The Chicago office will be continued in the Old Colony Bldg. under management of Victor H. Jones, formerly associated with American Blower Co.

The Pittsburgh-Des Moines Steel Co., Curry Bldg., Pittsburgh, Pa., has been awarded a contract with the B. & O. R. R. for three water treating plants for use on its system. These plants are located at Tontogany, O., Wapakoneta, O., and Twin Creek, O., respectively. The Pittsburgh-Des Moines Steel Co. also has under construction water treating plants for the C. & O. R. R. at the following points on their system: Russell, Ky., Huntington, W. Va., Wheeler, O., Robbins, O., Whitesville, W. Va., Taplin, W. Va., Taplin, W. Va., Brushton, W. Va.

The Pawling & Harnischfeger Co., of Milwaukee, Wis., manufacturers of excavators, cranes and machine tools, has recently appointed N. P. Farrar as its district manager with offices at 605 Stephen-Girard Bldg., Philadelphia, Penn., and 50 Church St., New York City.

Highest and Lowest Points in the World.—The maximum difference in elevation of land in the United States is 14,777 feet, according to the U. S. Geological Survey. Mount Whitney, the highest point, is 14,501 feet above sea level, and a point in Death Valley is 276 feet below sea level. These two points which are both in California, are less than 90 miles apart. This difference is small, however, as compared with the figures for Asia. Mount Everest rises 29,002 feet above sea level, whereas the shores of the Dead Sea are 1,290 feet below sea level, a total difference in land heights of 30,292 feet. Mount Everest has never been climbed. The greatest ocean depth yet found is 32,088 feet, at a point about 40 miles north of the island of Mindanao, in the Philippine Islands. The ocean bottom at this point is therefore more than 11½ miles below the summit of Mount Everest.

Equipment for Railway Bridge and Building Service

Abstract in Railway Engineering and Maintenance of Way of Committee Report Presented Oct. 17 at Convention of American Railway Bridges and Building Association

Employes should be cautioned not to abuse tools. Motor cars, hand cars and push cars are frequently loaded beyond their capacity, thus bending the axles and causing needless energy to propel this equipment and expensive delays. Chains, jacks, rope, chain hoists, stone hooks, timber hooks, and wire rope, must not be strained beyond the safe load, as this practice is not only unsafe, but destroys property and decreases the efficiency by not having tools in proper condition for future or emergency work.

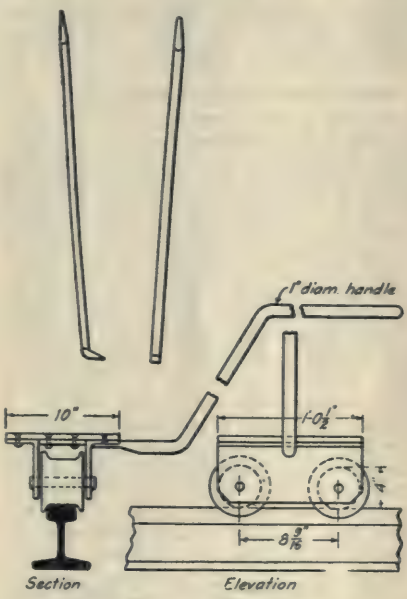
When gangs are moving from one job to a succeeding location the time can be used profitably in repairing and making various kinds of equipment. Carry hook handles and cant hook handles can be made from a good quality of timber pile heads (preferably hickory) which will give far better service than the turned handles furnished by the store department.

Probably no individual tool is more used by timber gangs than pinch bars. A considerable number of coil car springs are continually being scrapped. This class of material makes exceedingly good pinch bars and they are easily made in portable forges carried by most bridge and building gangs.

Bridge Dolly.—The bridge dolly illustrated is used by the Southern Pacific Ry. The frame is made of structural steel shapes riveted together. This tool will last longer and handle heavier loads than the ordinary dolly with a wood frame. It can be constructed by any structural steel gang at a nominal expense.

The Duluth, Missabe & Northern Ry. has found that the use of an air rivet hammer to settle the track spikes and line spikes hastens the completion of the decking of timber bridges, especially in preparing the track ahead of a pile driver on a 10° curve. It was also used to drive drift bolts. As the pile driver had its own air brake equipment it was an easy matter to furnish enough air for the hammer.

Shackle Bar.—Various devices have been used to remove drifts, such as shackle bars, reconstructed track jacks, and claw bars. The shackle bar shown has proved exceedingly useful and saves considerable time and expense. The shackle bar consists of a modified form of a claw bar with a cutting edge and a clevis, also with a cutting edge which grips the drift on the opposite side of the bar. The clevis is pin-connected to the shackle bar and made of such length that the two cutting edges are a small distance apart vertically when holding



Bridge Dolly and Shackle Bar.

the drift. The greater the force exerted on the end of the bar the tighter the grip on the drift, which forces the bolt to be lifted out of the timber a small amount and the bolt is quickly removed by successive lifts. Before using the shackle bar it is necessary to cut a notch about ¾ in. deep in the old timber so that the cutting edge can grip the head of the drift.

Cutting and Welding Outfit.—The acetylene cutting and welding outfit

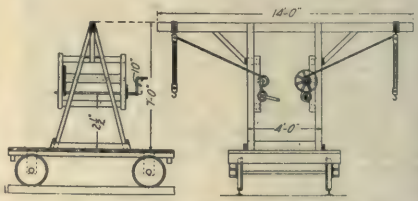
has probably saved more money in comparison with its initial expense than any other item of bridge equipment. One man with an acetylene torch will cut off more rivet heads than two squads can bust off by hand work. It is especially useful in cutting off girders, angles, I-beams and plates where a close fit is not required. Castings on pile drivers and pumps can often be welded in place and returned to service, thus avoiding loss of time.

The renewal of caps on trestles where traffic is frequent allows but a limited time for bridgemen to do their work. The time required to change trestle caps depends on the removal of the drifts, which can easily be accomplished by jacking up the caps about two inches and burning them off close to the pile. The use of tne acetylene torch for burning drifts may easily save 25 per cent of a gang's daily payroll on large jobs.

Pneumatic Tools.—Pneumatic motors will greatly expedite the work of boring holes incident to the construction of docks, draw bridge protection piers, cribs and the complete renewal of long trestles. The boring of 3,600 holes by compressed air on a reconstructed crib saved, by actual test, an equivalent of one working 192 days. The holes varied from 24 in. to 34 in. in depth. One man operating a pneumatic auger will bore holes through the guard timber and ties on trestles fast enough to keep a small gang busy placing the bolts and drifts. A large number of roads have pneumatic tie tamping machines, which provide portable air compressors for pneumatic boring. The compressors are easily removed from the track and can run a limited distance on the track under their own power.

Tie Dappers.—When a large number of bridge ties are to be renewed a tie dapper equipped with a circular saw will save considerable expense in labor. An actual test showed that three men dapped from 85 to 90 ties per day, which was about 50 per cent more than could have been cut out by hand labor. It is questionable whether the dapper is economical on small jobs, as the initial time consumed in setting up the machine will offset its saving. Where a considerable width of the ties is to be dapped it would probably be cheaper to have the material planed to a uniform depth on one face. Some bridge supervisors object to planing ties, as it removes the dapped shoulder and permits the track to get out of line more easily.

Pulling Devices. — The ordinary winch supplied to most bridge gangs is a useful part of their equipment. There are also several hand power pulling devices on the market which are lighter and can be installed more readily in places inaccessible to the winch. The hand power puller is easily transported by two men. It is operated by one man and can pull about 48 tons when 100 lb. is applied at the lever handle. This device can be used for removing large stumps, trees and rocks, wrecking buildings, moving houses, loading and unloading heavy material, raising bents, pulling bridges in place, dismantling bridges, demolishing piers, pulling pile clusters together, removing boilers from buildings, moving heavy machinery and cars, and pulling pipe together, and can be applied to various other uses in bridge and building work. This machine will save the services of at least two men as compared with a winch.



Portable Gallows Frame for Handling Stringers.

A portable forge and necessary blacksmith tools are almost indispensable with each gang. They will save time in getting tools repaired and returned to service. Various repairs can be made, such as the sharpening of picks, track chisels, pinch bars, claw bars and shovels, and the welding of chains, bolts and other tools.

The chain hoist should be given more consideration. It can be used for about the same work as the two-sheave block and tackle. In general, one man operating a chain hoist will accomplish the same results as one or two men operating tackle blocks. Another advantage of the chain hoist is

that it will hold a load at a certain height, while a load suspended by tackle blocks lowers, due to the stretching of the rope.

Equipment that is used infrequently and is expensive, such as high duty jacks of over 23 tons capacity, tie dappers, portable pneumatic compressors, air motors, small concrete mixers, acetylene burners and the larger types of steam and centrifugal pumps, should be stored at division headquarters and be shipped as required for special work.

Pneumatic Hammers.—There are still some hand operations that should be done by power. Some form of a light pneumatic hammer for driving small sheet piling, operated by air furnished from a tie tamper compressor, would be of considerable assistance to a small gang. The steam hammer is very useful for this work, although most maintenance jobs are too small to warrant the expense of setting up a steam plant. In changing or repairing old masonry, it is desirable to drill holes for iron pins in the old masonry so that the work can be bonded together. The drilling is usually done by hand, requiring the services of two men in each squad. If some form of light pneumatic drill could be built and operated by one man, considerable time and expense would be saved on such jobs.

Particular care should be exercised to obtain tools of good quality. Poor tool equipment is expensive, as the time required to make repairs and the inconvenience due to breakage will more than offset any saving in first cost. Inferior grades of chopping axes, adzes, rope, shovels, jacks, etc., will not only retard the output, but discourage the better class of employes that usually take pride in their work.

Cement Gun.—The cement gun should be given consideration by bridge and building men for the purpose of coating masonry and structures with cement mortar. This equipment is particularly useful for repairing the concrete on the underside of overhead bridges and in the tops of tunnels where the blast from locomotives has cut out portions of the masonry, leaving the reinforcing exposed. It is necessary to cover steel work with mesh and preferably to sand blast all surfaces before applying the cement coating. Where the amount of concrete is small the cement gun will produce more satisfactory results than the pouring of cement in forms, as gunite is forced in place by air pressure, thus producing concrete with a greater density.

Special Tool Equipment for Water Supply Gangs.—The wireless pipe locator has proved useful in locating water pipes, valves, meters, etc. However, the magnetic dipping needle is another simple instrument that can be used more particularly to locate uncharted valves and service boxes. It is convenient for locating such facilities under depot platforms and pavements, and will work accurately even when the valev is covered with ice, snow or even 12 in. of concrete.

The electric leak locator is valuable in locating leaks, particularly under pavements, concrete and platforms, where the water will follow the soft fill of the trench before finding an outlet.

A rather unique and efficient outfit is now obtainable for thawing frozen water pipes, which consists of a small generator coupled directly to a gasoline engine mounted on a truck. The entire equipment is operated as a unit, and will prove very serviceable, particularly in districts remote from electric service. In electric thawing as in all electrical work, the prime factor is to make the proper contacts with the pipe.

Where the larger sizes of water pipes are to be laid a long distance and require exceptionally good backfilling, the pneumatic tamper with a portable air compressor is a great labor saver and will produce better results than hand tapping. Two pneumatic calking hammers on 12-in. mains and larger will do the work of six to eight men more satisfactorily.

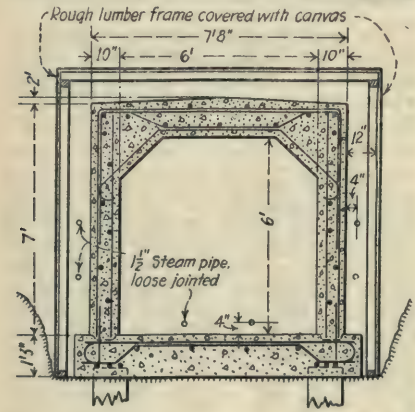
Railroad to Use Motor Trucks for L. C. L. Freight.—The Pennsylvania R. R., according to a press report, has contracted with a motor truck corporation to handle short-distance package or less-than-carload freight in the densely populated territory between Philadelphia and Wilmington, Del., and has abandoned two daily freight trains between these paints. There was no change made in rates, the company announced.

Concrete Culvert Construction in Zero Weather

Method Employed on Canadian National Railways in British Columbia Described in the Railway Review

By M. A. BURBANK,
Assistant Engineer, Canadian Northern Rys.

In November and December, 1922, at Endako, B. C., a reinforced concrete culvert, 6 ft. by 6 ft. by 128 ft. in dimension, was built under an existing pile trestle on the Canadian National Ry. Due to the fact that the temperature in these two months ranged from 20° above zero to 53° below, considerable care had to be taken to keep the concrete from freezing. To anyone doing concrete work north of latitude 53, this will be of little interest; it is only a summary of usual practice. In brief the procedure in this territory is to heat the aggregates and water, house in the work and heat the house.



Sketch Showing Housing for Cold Weather Concreting.

Before any concrete was deposited in the floor slab two 1½-in. steam pipes were placed the full length of the culvert, 4 in. above the top of the slab. Canvas was placed over the pipes and propped up to leave an air space below. Steam at 50 lb. pressure was turned on for 48 hours, until all parts coming in contact with the concrete were thoroughly thawed and warmed. The mixer was placed on the embankment near the end of the bridge, and about 100 yd. from the culvert, and concrete was taken in cars from the mixer and dropped through a canvas chute from the bridge direct to its position in the work. Because of the exposure to air at a temperature of 20 to 50° below zero during the 100-yd. haul from the mixer to the chute, both aggregate and water were heated to a high temperature before going into the mixer. Aggregate when it reached the work, regardless of exposure to severe weather, was too hot to touch with the hands. Sometimes the canvas over the clab was raised to allow tamping, and sometimes the tamping bars were worked through holes in the canvas. The most important feature, the protection of the concrete from frost, was never overlooked.

Seven days after each section of the floor slab was finished the barrel forms were placed. Outside the forms a rough lumber wall was built leaving a 12-in. air space. Over the tops of the two outside walls, a canvas was thrown, housing in the work. The outside air space was heated with two 1½-in. steam pipes placed longitudinally on each side. Both ends of each section of the barrel were then closed in with canvas. A stove with water boiling continually was kept going until seven days after the barrel was completed.

It is estimated that this winter concrete work cost $1.50 per cu. yd. of concrete more than work done under ordinary conditions. The results on this particular culvert are very satisfactory. The concrete looks good, has the right ring and shows no surface cracks even after standing exposed during three months of very severe weather. The writer was in charge of the work.

In conclusion it might be mentioned that the summer season in this territory is so short that small progress can be made on important projects unless the engineer is willing to carry on his work during the winter months. This practice is becoming more common, and if proper precautions are taken, there is no reason why just as satisfactory results can not be obtained as in the warm months.

Pennsylvania Railroad Electrification.—The Pennsylvania R. R. has started work on the electrification of its Whitemarsh Branch which extends from Allen lane station on the Chestnut Hill branch, Philadelphia, to Whitemarsh station. The branch is six miles long. It is expected the first electric trains will be in operation about the first of the year.

Concrete Paving of Street Railway Track

Construction Methods at Chattanooga, Tenn., Described in Electric Railway Journal

With a view to securing permanently satisfactory results with concrete paving in and between tracks, the Tennessee Power Co., which operates the city railway lines in Chattanooga, Tenn., has lately used the track construction shown in the cross-section, Fig. 1.

The trench for the single track is 9 ft. wide and the bottom is inclined toward a 12x12-in. drainage ditch in which a 6-in. farm tile is laid. If the coil is soft, 2 or 3 in. of ballast is rolled into the bottom. The trench is about 22 in. deep at the middle and 2 in. less at the outside. Broken stone ballast is laid in the bottom to a depth of 8 in. at the middle, on which white oak ties creosoted by dipping one hour in hot oil and one hour in cold oil are laid. Standard 6-in. 100-lb. A.R.A. rail is spiked to the ties.

A concrete paving base with a 1-3-6 aggregate mixed one and one-half minutes is poured between and over the ties, covering them to a depth of 2 in. The concrete base is deepened slightly under the rails by scraping out the ballast before the base is poured.

The paving base is made about 9 in. deep outside of the rails, where, as in the case illustrated, an asphaltic concrete paving is to be laid by the city. Outside the rails the concrete is depressed to accommodate two or more rows of stretcher brick, which are laid on a sand cushion.

The concrete between the rails is 4 in. deep, of 1-2-4 concrete mix, surfaced as indicated in the cross-section.

Contour strips of wood are laid in the rail flangeways while the concrete is soft, and the surface is smoothed by means of a level board. The surface is not crowned. After the concrete has hardened sufficiently to "stand up," the flangeway is smoothed by means of a special grooving tool shaped in the form shown in Fig. 2.

Expansion joints are placed 15 ft. apart, a space ¾ in. wide at the top battered to ½ in. at the bottom being left for this purpose. A board with the proper taper is used in forming this joint, and the concrete is mixed with as little water as possible to enable it to stand up when the expansion joint board is removed.

After the removal of the board, a grooving tool, such as is used by sidewalk layers in marking lines in concrete surfaces, is drawn through the groove, slightly rounding the edges. Pitch is poured into the joint after 21 days.

The concrete paving and the ballast tamping are done under traffic. Sometimes ten tampings of the ballast are needed when the ground is soft. The tamping is done with ordinary hand picks. Care is taken to see that no flat-wheel cars go over the line while the concrete is setting, and all cars are run during this period at reduced speed.

For the first seven days the concrete is continually wet down to permit uniform setting.

The cost of this work was from $1.25 to $1.50 per yard on two recent jobs on Walnut St. and Harrison Ave.

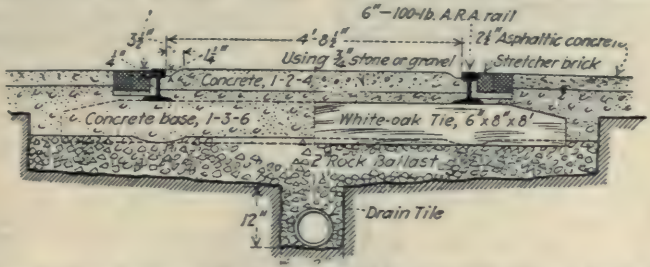


Fig. 1. Typical Cross-Section of Track for Paved Streets With Concrete Paving As Used in Chattanooga.

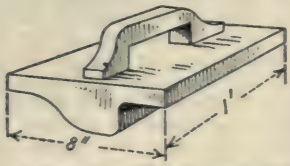


Fig. 2. Grooving Tool for Forming Flangeway in Concrete Paving.

Slide Curing on Yazoo & Mississippi Valley R. R.

Some novel betterment work now in progress on the Yazoo & Mississippi Valley R. R., a part of the Illinois Central System, is described in a recent issue of The Earth Mover.

The Yazoo & Mississippi Valley R. R. runs south from Memphis through the Mississippi River delta. The soil, known as delta gumbo, forms a very unstable railroad bed. During wet weather it slips and slides out from the original embankment until the fill becomes from 30 to 40 ft. wide instead of the few feet necessary for a single track railroad. The result has been a constant expense for filling in the road bed and raising the track.

A few years ago the railway officials decided that it would be cheaper and better to replace the gumbo road bed with some more stable material. At the start they put their idea into effect by taking out the embankment on one side of the track, using team equipment; replacing the material with clay; then shifting over the track to the new road bed. Later an Erie steam-shovel was installed in place of teams. This shovel moves down the right of way and takes out the gumbo embankment on one side of the track, casting the material in spoil banks. Hill clay is then dumped into the excavation, the material levelled with a spreader car, and the track shifted over to the new road bed.

Last year two stretches of road-bed, each 3 miles long, were treated in this manner. This year 6 miles were improved by bringing in Paducah gravel and raising the road-bed with that material, without shifting the track. On one stretch of 3 miles near Lambert, Miss., it has been necessary to resort to the operation described, of replacing the gumbo with hill clay before shifting the track. Thirty miles altogether will be improved in this way, a few miles each year.

One of the interesting features of this work is the distance which the clay has to be hauled. A pit was opened along side the track about 8 miles south of Memphis and the clay hauled from there about 90 miles to the excavated road-bed, one train load each day.

Two trains are operated, one consisting of 59 Western air dump cars of 30 cu. yd. capacity, the other of 60 old-time ballast cars, which require the use of an unloading plow. Thirty-three additional 30-yd. Westerns have been purchased for this and other work. Roach & Stansell, Memphis contractors, are doing the loading under contract, using a Bucyrus shovel with a 2½-yd. dipper. A train is loaded during the day and taken down to the dump at night, where it is unloaded during the following day. When the loaded train arrives at the dump the locomotive is released to pull the empty train back to Memphis for another load.

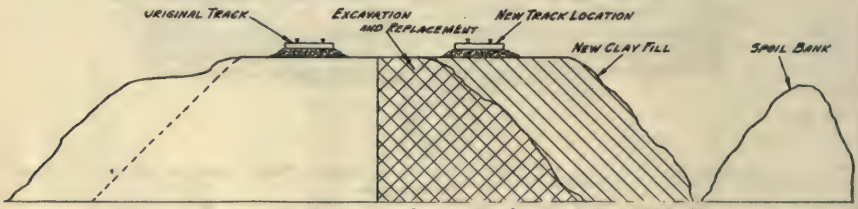


Diagram Showing Method of Replacing Gumbo Road Bed With Clay.

While the work is costing a great deal of money in the aggregate the cost per cubic yard, including loading, hauling, dumping, spreading and shifting track is surprisingly low. The railroad, of course, has the advantage of a contractor in hauling, the bare operating cost of the train being much less than a freight rate based on the entire cost of doing business.

Memphis clay and the air dump cars are used by the Yazoo & Mississippi Valley Railroad in trestle filling, bank widening, and other work on different parts of the line. The material has been hauled from Memphis as far as Rolling Fork, Miss., a distance of 175 miles, to build sidings. The longest train sent out from the Memphis pit up to date has consisted of 71 cars, carrying more than 2,000 cu. yd. of hill clay.

An Easy Method for Properly Directing the Holes for V-Cuts in Tunnel Driving

A useful method of directing holes for V-cuts in tunnel driving, worked out by Henry Bock, Jr., engineer of the Uten Contracting Corporation, is described in a recent Du Pont Explosives Service Bulletin by Charles

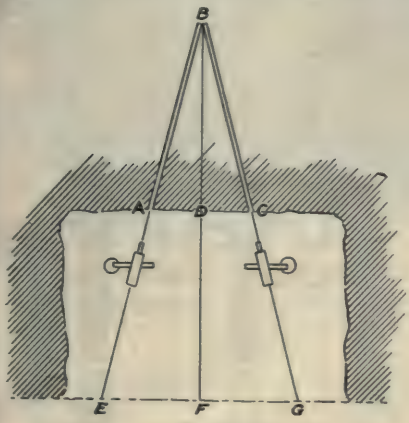


Fig. 1.

S. Turter, Technical Representative, E. I. du Pont de Nemours & Co., Inc. The description follows:

In Fig. 1 suppose that the points A and C represent points in the two vertical lines painted on the face where a pair of cut holes are to start. Then a line drawn between these two points together with the lines of the holes to be drilled from these points to form the V, will compose the triangle ABC, in which the base AC is the distance between the collars of the holes, and the altitude DB is the depth of the cut.

Next, is the sides AC and CB are extended to twice their length, a second triangle, EBG, is formed. In the language of geometry, ABC and EBG are similar triangles. Further, the sides of similar triangles are proportional. Therefore, since EB is twice AB and GB is twice CB, it follows that EG must be twice AC and that EF and FG are separately equal to AC.

Now, what is the value of these mathematical facts in regard to the problem of directing cut holes? Simply this: they make it easy to run the lines CG and AE from the face back into the tunnel and hence to place the drills in the proper position to drill the holes CB and AB to meet at B.

To run the lines CG and AE, take two lengths of the longest steel that is to be used in drilling the cut holes and mark on each the point near the shank where the collar of the hole will come when the drilling is finished. This point can be readily determined by adding to the length of shank which will be taken up by the chuck of the drill the distance the drill is set back from the face. Now, by the use of the tunnel sights, find the middle point, D, between the lines painted on the face and from this stretch a carpenter's chalk line in the line DF. If a chalk line is not available and if the floor or muck pile is flat enough, a third long piece of steel can be laid on the floor with one end against the face at D to mark the line DF. Next, lay one of the marked pieces of steel on the floor with the bit against the right hand painted line on the face and move the shank end until the distance from the point marked on this end to the steel DF, measured along a line at right angles to DF, exactly equals the distance between the painted lines; that is, until FG equals AC. When this is done, the steel will be exactly in the line CG and will point

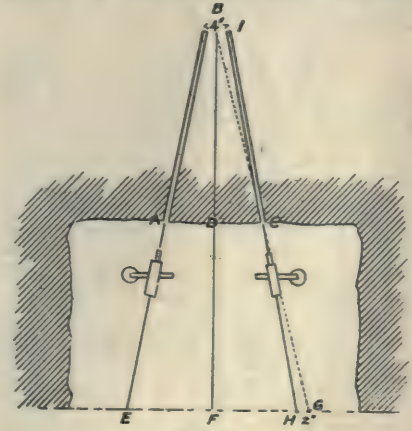


Fig. 2.

the direction of the hole CB. All that is then necessary is to move the drill on the arm until the center of the pivot is on the line CG, swing the drill until the center line of the machine is on the line CG, and begin drilling. If the same procedure is followed on the left hand side in run-

ning the line AE and placing the drill, the holes will follow the desired direction and meet at the bottom. After the first pair of cut holes have been drilled, the other holes for the cut can be easily lined up from steel extending from the first pair.

If desired, string may be used instead of drill steel to run the lines CG and AE as well as DF and the points G and E located by means of a measuring tape.

This method can also be applied to directing cut holes when conditions make it desirable to have some distance between the bottoms. Suppose, for instance, that it is desired to have the bottoms of the cut holes 4 in. apart as in Fig. 2. Run the line CG as before. From the point G measure back 2 in. toward the center line to find the point H. Now, keeping the bit of the steel fixed on the painted line at C, swing the shaft in until the steel takes th positione CH. Lining up the drill with this steel will give the cut hole the direction CI and make it end 4 in. from a hole drilled at the same angle on the other side. To find the proper direction for holes that are not to meet, corrections in Fig. 1 should aways be made from the sides toward the center line and should amount on each side to one-half the distance that is desired between the bottoms of the holes.

If the tunnel workings are so narrow that in drilling the cuts the last steel has to be sprung in order to get it in and out of the hole, then there will not be room to run the lines CG and AE back the full length of the hole to be drilled. In this case, these lines can be run back just half the depth of the hole. The base lines GF and EF should then each measure three-fourths of the distance between th lines painted on the face, that is, three-fourths of AC.

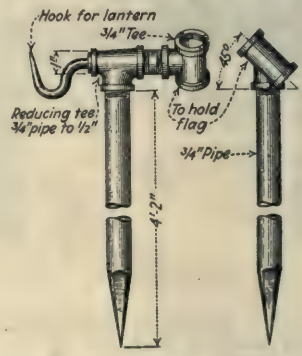
One of the chief advantages of this method of Mr. Bock's for directing cut holes for V-cuts is the fact that it is applicable to any depth of cut and can be carried out by the heading foreman without special calculation by the engineers for different depths of cuts. The accuracy that it gives to the direction of cut holes aids in blasting cuts to the desired depth because it enables the blaster to load the explosive charges in the position where they will do their best work. Hence it increases the advance per round and the speed of tunnel driving.

Pipe Staff for Flag and Lantern Signals

An efficient flag and lantern staff used by the Pacific Electric Ry. while track repairs are being carried out is described by Clifford A. Elliott in a recent issue of the Electric Railway Journal.

The rules of the road require foremen to place proper protection signals in advance of any work being carried out. These signals consist of a yellow flag during daylight periods and a lantern at night.

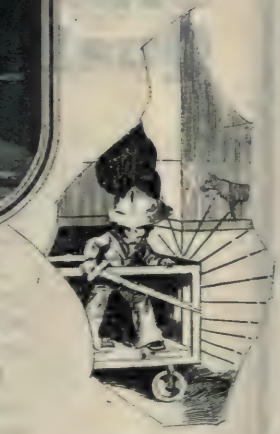
The staff used for supporting these signals is made of ¾-in pipe with two tees, a nipple and a hook at the



Flag and Lantern Staff.

upper end. The upright is 4½ ft. long and is pointed at the bottom so that it can be readily placed in the ground. A reducing tee ¾ in. to ½ in. is screwed to the upright. The small end of the tee is bushed and a 1-in. iron hook is provided for hanging a lantern. A nipple is screwed into the ¾-in. end of the tee and another standard ¾-in. tee is screwed to this. This latter tee forms the support for the flag. The tee for holding the flag is placed at an angle, as it was found that this was most suitable for giving trainmen an unobstructed view of the flag.

A Break in "Pittsburgh Plus."—On Dec. 6 the La Salle Steel Co., one of the largest manufacturers of cold drawn steel and alloy steel in the Chicago territory, announced that it had abolished the "Pittsburgh plus" practice of pricing steel and that its product would be sold on a Chicago base rate. It is said to be the first steel company in Chicago to make such an announcement.



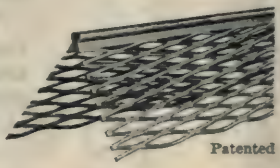
Crash—but the corner's safe! In the modern home, MILCOR metallic construction has not only made walls truer and more beautiful, but has provided a rigid metal base that keeps them permanently so. These homes are rooms in which to *live*—children can play—furniture can be moved. MILCOR walls take blows that would shatter ordinary plaster construction for they are formed on a foundation of expanded steel.

As an instance of what this better construction affords—for exposed corners, MILCOR *Expansion* Corner Bead is wired or nailed directly over the *Stay Rib* Lath. The plaster, when placed, clinches through the mesh of both the bead and lath, making the corner the strongest part of the entire wall. The true, *drawn* bead imbedded in the plaster acts as a guide while the wall is under construction, which assures an even surface and uniform depth. In the finished wall the unseen metal edge stands guard to take blows that would shatter ordinary plaster corners, and dissipates their force through the expanded metal wings without cracking or chipping.

Complete information as to the use of these modern building products or where they may be obtained will be supplied promptly on request.

MILCOR ***Expansion*** Metal Trim
MILCOR ***Expansion*** Corner Bead
MILCOR ***Expansion*** Base Screed
MILCOR ***Invisible*** Picture Molding
MILCOR ***Netmesh*** Metal Lath
MILCOR ***Stay Rib*** Metal Lath

Milwaukee Corrugating Company
Milwaukee – Kansas City – Minneapolis



Patented

MILCOR *Expansion* Corner Bead is wired, nailed or stapled directly over the metal lath—the plaster, when placed, *keying* through the mesh of both for great strength. The perfect cold-drawn head (just flush with the surface of the finished wall) although hidden from view, takes and dissipates without damage, blows that would shatter ordinary plaster corners. MILCOR Metallic Construction makes rooms *permanently* beautiful.

MILCOR
METALLIC BUILDING PRODUCTS

TELL THEM YOU SAW THEIR AD HERE

Portland Cement Stucco Is Quality Stucco

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A National Organization
to Improve and Extend the Uses of Concrete

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It is infringement to make, use or sell a patented invention without authority under the patent. Our patents have been sustained by the United States Courts in six different instances. Purchasers of our Mixers are protected.

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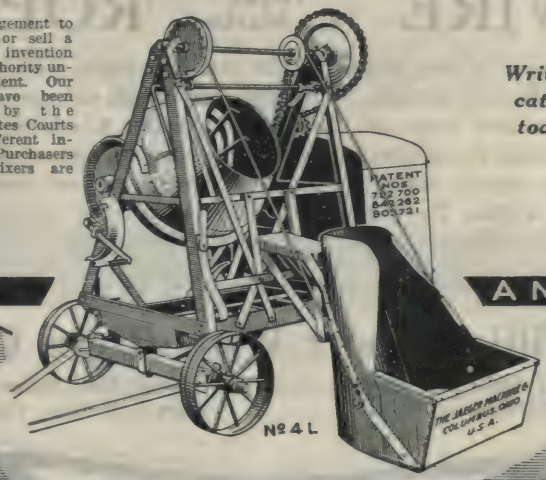

A MIX A MINUTE

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because it has proven to be the best ropes for Crane and Shovel service. They can buy much cheaper wire ropes and they can furnish wire ropes which do not indicate the grade, but in the use of WILLIAMSPORT—they supply not only "quality" ropes but they contain the Telfax Tape marker. Ropes of other manufacturers do not contain this valuable protection.

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In the Clyde line, you will find standard equipment for any hoisting operation. Back of the equipment is a corps of engineers ready at all times to help you with your problems.

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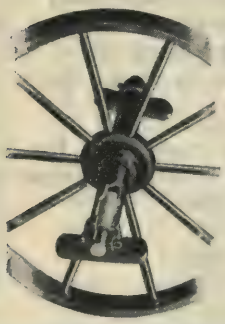
10 Spokes Instead of 8 Spokes

Self-Lubricating



Shorten the distance between spokes on tire and you obviously strengthen the wheel.

Then too there is a self-lubricating bearing in each end of the Sterling wheel hub which lessens the effect of wheeling. Every Sterling barrow is equipped with this self-lubricating 10 spoke wheel. It pays to buy Sterling barrows for the wheel alone—it is different and better.

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Left—Concrete floor, Lunkenheimer Co., Cincinnati, O. Elastite Expansion Joint used.
Center — Street in South Nyack, N. Y., Cornelius Vanderbilt General Contracting Co., Inc. Elastic Expansion Joints every 30 feet.

Concrete roof deck, United Drug Co., St. Louis, Mo., Engineers, Harry M. Hope Eng. Co., Boston, Mass., Contractors, Westlake Construction Co., St. Louis, Mo.

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—all need Elastite Expansion Joint

ROOF decks need protection against expansion, building vibration, and exposure. Roads need protection against expansion, traffic impact and exposure. Floors need protection against expansion, machinery and building vibration, and the shocks of heavy trucking.

Elastite Expansion Joint makes these stresses harmless, because each joint resiliently cushions the structural units against shock and vibration, absorbs expansion, and forms a water-tight seal between abutting units, preventing water-soaking of surfaces exposed to weather.

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1873—Fifty Years of Progress—1923

How Elastite Expansion Joint is water-tight

Elastite Expansion Joint yields easily to compression as concrete or brick expands, and expands as the abutting construction contracts, thereby insuring at all times a tight closure. It prevents the development of openings which fill with dirt or water, and allow frost action to cause heaving and cracking.

Carey Elastite
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PROVED AND ACCEPTED

Carey Elastite Expansion Joint is an asphaltic body, formed of a high-grade asphaltic compound carefully refined and tempered, sandwiched between two walls of asphalt-saturated felt forming an elastic, compressible joint. It is made in lengths, widths and thicknesses as required, can be cut to crown or to any special shape and comes to the job ready to use. 12-26

The architect's specifications for this fine service station of the Western Oil Refining Company, at Indianapolis, Indiana, required that ARMCO Ingot Iron be used for all sheet metal work, including the sash, sign, ridge roll, terminals, hip cresting, cornice, dividing mould, gutters and downspouts.

—because ARMCO lasts

The artistic and substantial appearance, so well combined in this finely built service station, implies not only good judgment in design but discriminating care in the selection of materials. The choice of the metal work was necessarily based on its enduring quality, in order to resist the cumulative effects of weather and exhaust gas fumes.

ARMCO Ingot Iron was specified because of its proved rust-resisting qualities. When Ingot Iron is used in the form of a galvanized sheet, the purity of the base metal in itself retards corrosion. It also prevents excessive contamination of the spelter, thereby increasing the durability of the zinc coating and multiplying the rust resisting properties of the whole sheet.

The American Rolling Mill Co.

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Servicised insulation is a pre-treated, delaborized, matted and thoroughly compressed insulation, pre-treated at our factories by thorough saturation of the surface and edges, produces the most satisfactory waterproof insulation material for lining the walls of houses, refrigerator cars, barns, roofs, etc.

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Labor cost is reduced more than half where pre-treated waterproof insulation is used.

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The Cube is built in capacities from 2½ to 56 cubic feet; the Cub-Hex capacity is 4 cubic feet and Drum capacities are 4 and 7 cubic feet per batch. These are designed to fit any job, but each has particular features that make it most practical for work in hand.

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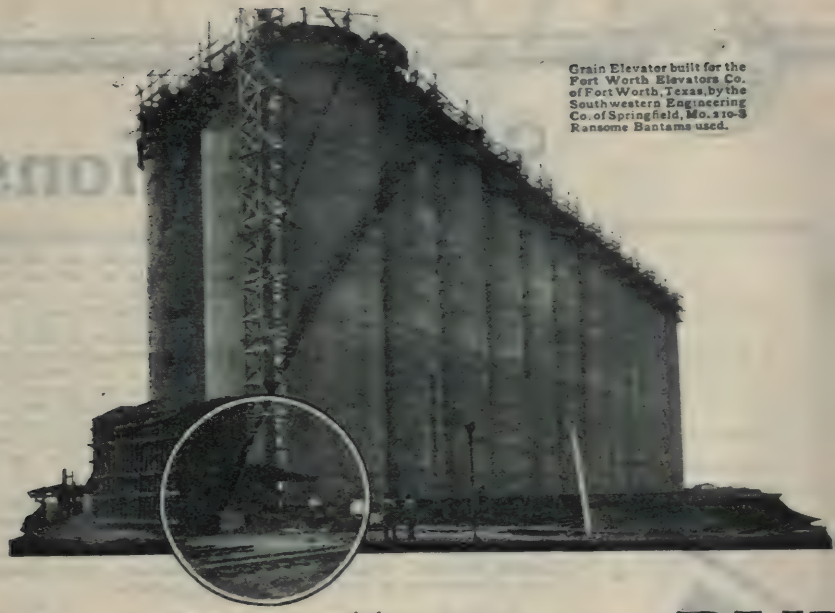

Grain Elevator built for the Fort Worth Elevators Co. of Fort Worth, Texas, by the Southwestern Engineering Co. of Springfield, Mo. 210-S Ransome Bantams used.

It's a small mixer BUT

It certainly does turn out BIG yardage. On this he-man grain Elevator at Fort Worth, for instance, two Ransome 10-S Bantams poured all the concrete from the foundations up.

5800 cu. yds. in 14 days! That's how the Bantam handles a job. It may be a "Bantam" in size but it's one "Whopper" for yardage.

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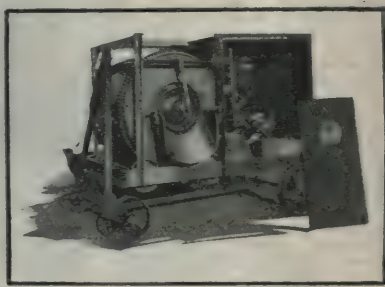

No. 10-S Ransome Improved Bantam Mixer. On Trucks with Gasoline Engine.

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Building Mixers, sizes 1-S__; 7-S__; 10-S__; 14-S__; 21-S__; 28-S__; 56-S__. Driven by Belt__, Steam__, Gasoline__, Electric__
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A steel specification is a document for guidance to the manufacturer in producing an article, and a protection to the purchaser in accepting it. A specification should be written only after careful study of the production of the article, and an equally careful study of the use to which it is to be put.

Specification A-16-14, covering Rail Steel Bars, was issued by the American Society for Testing Materials only after the most careful investigation that has ever been made of any reinforcing material. In 1913, Professor W. K. Hatt, then of Purdue University (now on Mr. Hoover's staff), made over 3,000 tests on as many samples obtained under normal working conditions from four separate mills. Professor Hatt found that Rail Steel Bars had unusual strength, and furthermore, "excess ductility for its strength above usual grades of steel."

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Specify your reinforcing steel to meet A. S. T. M. Specification A-16-14, or equal.

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(Reinforcing Bar Division)

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SEND FOR THIS VALUABLE BOOK—FREE

The first and only authoritative and comprehensive treatise on concrete Reinforcing Bars and containing most important information on the manufacture, qualities, and use of Rail Steel Bars. The cost of this booklet makes it necessary for us to control its distribution and we ask that your request for copy be sent us on the letterhead of an architectural or engineering firm. Write the nearest office. Address Dept. B.

Sears, Roebuck & Company Building, Dallas, Tex. View during construction.

Lang & Witchell, Architects, Hughes-O'Rourke Const. Co., Contractors.

RAIL STEEL FOR CONCRETE REINFORCING

1924 USHERS in the fourteenth year of the successful performance of WONDER MIXERS—the *original* of the Single Opening Tilting Type.

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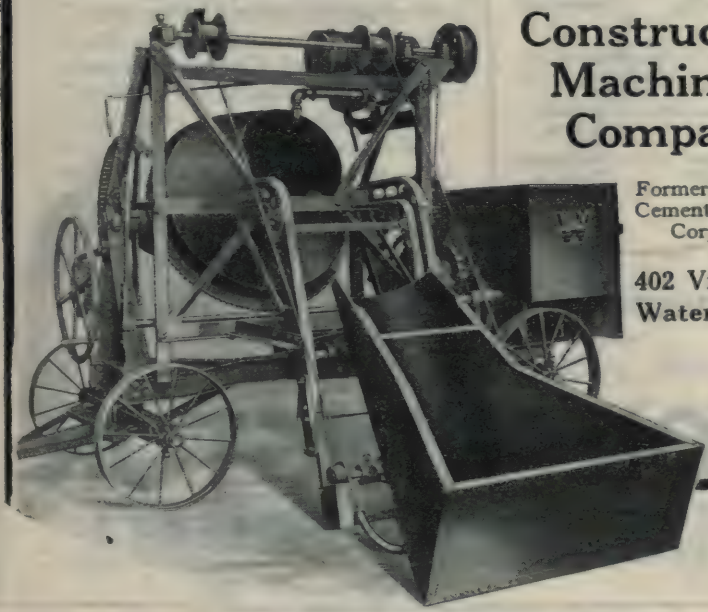
Therefore we wish to take this opportunity to assure you that this same high grade design and quality will be found in each WONDER unit during 1924, and the WONDER Trade Mark will again be your assurance of this same dependable service.



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Formerly Waterloo Cement Machinery Corporation

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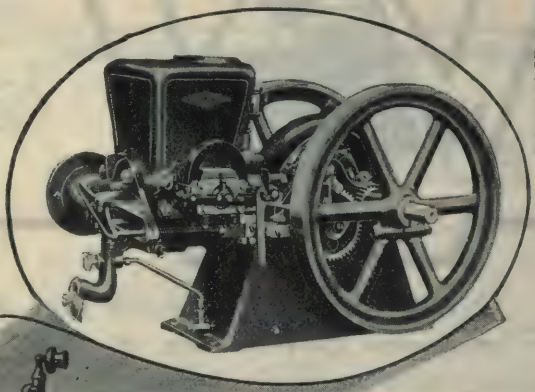
Waterloo, Iowa



This is but one of the Worthington line of kerosene and gasoline engines. The complete list embraces engines from 1½ to 25 H. P. Some with throttling governer and others hit-and-miss governing.

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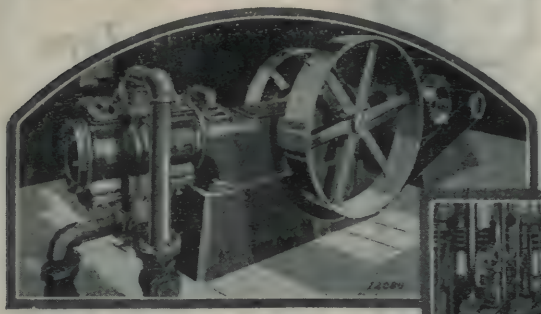

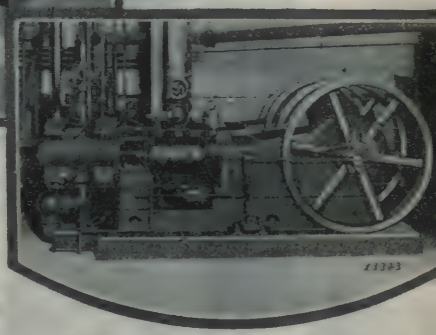

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Rock *Drills*

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Buildings

1323

MONTHLY ISSUE OF

ENGINEERING AND CONTRACTING

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221 East 20th St., Chicago

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LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 904 Longacre Bldg., 42d St. and Broadway
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Vol. LX. CHICAGO, ILL., DECEMBER 26, 1923 No.

Zoning Wins in Chicago

All who take other than a wholly selfish interest in the development of our cities will, we believe, rejoice at the defeat of the first legal attack upon Chicago's carefully prepared zoning ordinance. This defeat was in the form of a refusal by Judge Friend to grant an injunction restraining certain city officials from interfering with the construction of an apartment building in a district which had been zoned for single family dwellings. Further attacks may be expected, but with this important initial victory the position of zoning is greatly strengthened.

The lmitation of use of certain city areas, or zones, is the result of no mere desire to meddle. It is undertaken as a protection of property values and of rights which property owners believe they are entitled to enjoy. Every person has seen some district of comfortable and pleasant homes spoiled by the invasion of a factory, garage or other objectionable establishment. Residents have left and their places been taken by others whose financial means per mitted no better location; old resi dents who could not leave have ha to put up with changed and undesir able surroundings; property value have fallen; and the whole distric has remained for years nondescript— neither industrial nor residential. I the lands ultimately bring highe prices for industrial than they did fo residential use the houses, whic usually are worth much more tha the lands, are practically a total loss Further, there is the period of change sometimes very long, during which in stead of an increase, there is ofte a large reduction in most of the lan values. These losses are measurabl more or less accurately in terms o money, but the hardship of bein forced to give up one's chosen hom is not so measurable. Practically i is eviction. The intrusion of store and apartment buildings is very littl less serious than the intrusion of in dustry. The residents will be slowe to give up their homes, but thei ultimate removal is inevitable.

single family house is ruined for most people when an apartment is built beside it.

The case of a retail store area invaded by industry is of the same character in all but two ways—sentiment and personal attachment are not involved; and instead of the prospect of an ultimate increase in land value there is the prospect of a permanent reduction. One might think that under this last condition such changes would not take place, but the fact is that the poorer use repeatedly has driven out the better. An individual sees a chance for profit—often temporary—in converting his property to an industrial service. The retail store or office adjoining it is immediately depressed and in time is given up as no longer suitable for its old purpose. It too is then turned over to industry, and the evil influence is extended. Thus the change is continued, and rarely is it checked except by heroic measures.

The zoning ordinance is the community's means of protecting itself from damage by the individual who regards only his own interest. It is as reasonable as the law against reckless driving. There can be honest differences on the subject, but the man who simply for his own profit tries to break through a zoning law against the wishes of all his neighbors deserves the maximum of public reprobation.

Winter Building Expected to Break All Previous Records

Editorial in Building Supply News for December 4.

An inquiry now being made by Building Supply News throughout all branches of the construction industry has already brought enough response to make it certain that the winter of 1923-1924 will undobtedly break all previous records for construction and building supply activity.

Everywhere dealers, contractors, architects, manufacturers and even the prospective building public are discarding old prejudices and out-of-date notions against winter building, and the result is that new construction now under way and planned for the next five months straight through the winter in almost every section of the northern zone of the United Stats, above the snow line, is way beyond figures for past years.

Despite all the prophets of pessimism, September and October, and now November, have rolled up totals of construction surpassing almost all previous years in American construction history, and a great deal of this is new construction, being started with the definite purpose of continuing right through December, January, February and March, willy-nilly, no matter what the mercury may do or the weather bureau may say.

Suggestions for Filing

Editorial in The Architectural Forum.

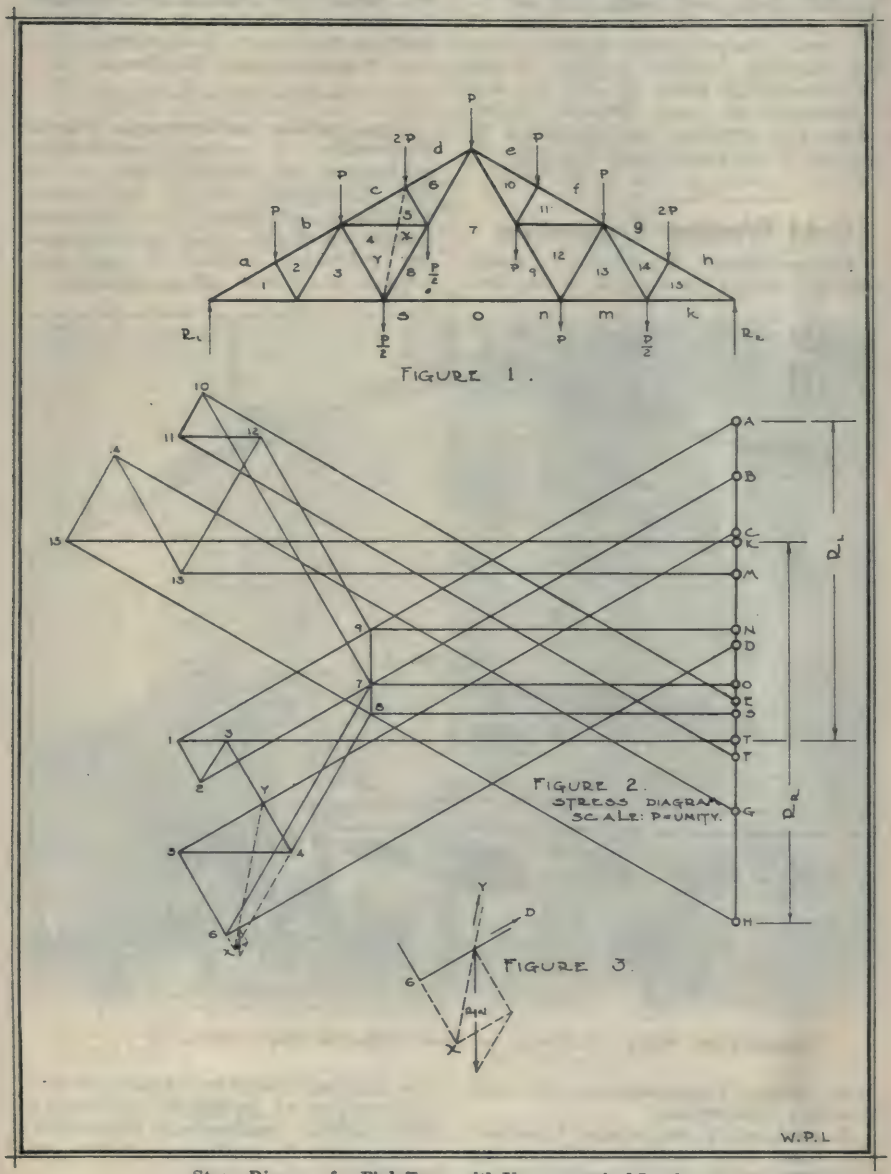
The value of much of the advertising matter which the manufacturers of building material issue to architects and engineers is minimized or lost unless such matter be so filed that it is instantly available when it is needed. The great diversity in the filing systems in use by different architects has led to the studying of the subject by a committee of the American Institute of Architects, the result being a brochure describing the Standard Construction Classification recommended by the Institute.

In many offices when advertising matter of this nature is filed at all it is arranged alphabetically under the names of the manufacturers. This plan, of course, makes it quite necessary that the individual consulting the file be familiar with the names of the concerns manufacturing the commodity in question. One interested in plate-glass, for example, must be informed of the names of the manufacturers of such glass or the most complete file possible will be of little service. According to the Institute's plan, however, the many subjects in which an architect is likely to be interested, from the first detail of preparing a building site to the final detail of equipment, are so divided, sub-divided and cross-referenced that a circular, catalog or other detail giving information if worth filing at all is so filed that it is quickly had when wanted. This excellent system of filing is also recommended to the attention of the manufacturers whose advertising forms much of the matter filed, for their co-operation will aid materially in making the use of the system effective, thus giving their advertising matter a far greater and more permanent value.

Solution of a Fink Truss

To the Editor: The article in reference to the solution of the direct stresses of a Fink truss in your issue of Nov. 28 is very interesting. However it appears that the example used by Mr. W. Grierson is a very special case in that both the truss and the top chord loads are symmetrical about the center line. The solution orginally given by me (see Oct. 24 issue) was an illustration of a general solution to cover a simple case for a group of men who do not class themselves altogether as experienced engineers.

Accompanying herewith is the stress diagram for the same truss with loads which are unsymmetrical about the center line. It would be in-



Stress Diagram for Fink Truss with Unsymmetrical Loads.

teresting to the structural engineer, I believe, to have a stress diagram for this truss as loaded, by the use of the method as shown in the November issue.

The portion of the stress diagram at the points "6" and "X" is shown to a larger scale in figure 3.

It will be noted that the stress diagram closes, giving a closed force polygon about each point, and the direct stresses, with the character of the stress, may be read directly from the diagram in this solution of the unsymmetrical loads as did the one illustrated in your October issue, where the problem was simplified by the use of a symmetrical loading.

C. R. McAnlis.

Cold Weather Concreting

To the Editor: I note with a great deal of interest the Article in the Oct. 24th issue "Fundamentals of Cold Weather Concreting."

A good many years ago, I personally used this method of enclosing buildings and in 1916 I built the first half of the Bank of Buffalo in the winter months. This building, is about 50x100, equal to about a 6-story building, the exterior walls being all of Indiana limestone and the interior of reinforced concrete and steel construction. I also enclose a photograph showing the house that I built around this for winter work, the entire structure above the ground being carried on during the months of December, January and February.

Buffalo, N. Y. J. W. Cowper,
President, John W. Cowper Co.

Housing for Winter Concreting on Bank of Buffalo Bldg., Buffalo, N. Y.

Construction Conference at Purdue University.—A unique construction conference was recently held at Purdue University when contractors, architects, engineers and craftsmen assembled at the bid of the engineering extension service of that university to discuss affairs relating to the building industry. Practical demonstrations of improved methods in the various professions represented were given by professors of the university.

Shortcuts for Solving Problems in Concrete Design

Combined Axial and Bending Stress

By R. P. V. MARQUARDSEN,
Assistant Engineer, Chicago Terminal Improvement, Illinois Central R. R.

The following method for finding the amount of steel reinforcement required at any section of a retaining wall, arch, or other concrete structure of rectangular cross-section, subject to combined axial and bending stress, was devised some years ago by the writer and has been used continuously since by him in solving problems of this nature.

As the method is direct and easier to apply than the usual cut-and-try methods ordinarily given in textbooks, it might perhaps be of general interest.

In presenting the method, the side of the section under consideration nearest the normal component of the outside forces acting on the section will be referred to as the "compression" side and the side farthest away from the component as the "tension" side (whether or not tension actually occurs) and the following notation will be used:

A_s = cross-sectional area of steel reinforcement in tension.
A_s' = cross-sectional area of steel reinforcement in compression on "compression" side.
A_s'' = cross-sectional area of steel reinforcement in compression on "tension" side.
b = breadth of rectangular cross-sectio under consideration.
f_c = compressive unit stress in outside fiber of concrete on "compression" side.
f_c' = compressive unit stress in outside fiber of concrete on "tension" side.
f_s = tensile unit stress in steel reinforcement
f_s' = compressive unit stress in steel rein forcement on "compression" side.
f_s'' = compressive unit stress in steel rein forcement on "tension" side.
k = ratio of depth of neutral axis from out side compression fibers of concrete t distance between center of tensile ste stresses and outside compression fiber of concrete.
j = ratio of distance between centroid c compressive concrete stresses and cente of tensile steel stresses to distance be tween outside compression fibers of con crete and center of tensile steel stresse
n = ratio of modulus of elasticity of ste to that of concrete.
N = normal component of the resultant c all outside forces acting on the rectangu lar cross-section under consideration.

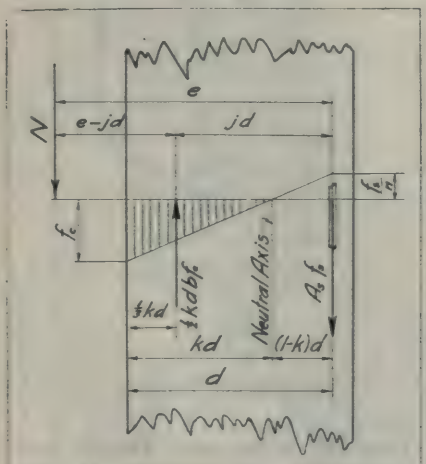


Fig. 1.

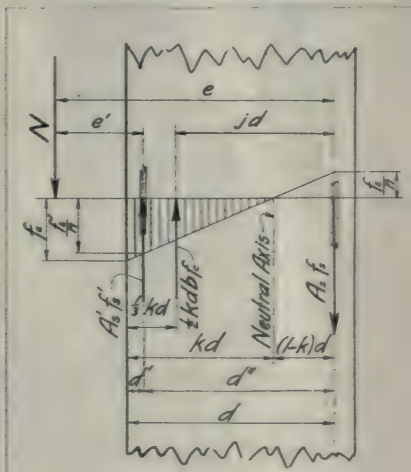


Fig. 2.

In addition certain distances will b represented as indicated in the sev eral figures.

There are four general cases to b considered, viz.:

I. When only tension reinforcement is r quired.
II. When both tension and compression r inforcement is required.
III. When only compression reinforcemen on "compression" side is required.

IV. When compression reinforcement on both "compression" and "tension" sides is required.

Case I. When only Tension Reinforcement is Required. (See Fig. 1.)—

Given: b, d, e, f_s, n and N.
To find: A_s and f_c.

In Fig. 1 is indicated the magnitude and location of the normal component of all outside forces acting on the rectangular cross-section under consideration and also the magnitude and location of the resultants of the compressive stresses in the concrete and the tensile stresses in the steel reinforcement resisting and balancing the outside forces.

By taking moments about the center of the steel stresses, the moments

Fig. 3.

of these stresses become zero, and we may write

$$N \cdot e = \tfrac{1}{2}\, k\, d\, b\, f_c \cdot (1 - \tfrac{1}{3}\, k)\, d \quad \text{.....(1)}$$

Substituting in this equation for f_c the equivalent value of

$$\frac{f_s}{n} \cdot \frac{k}{1-k}$$

and bringing all k's on one side of the equation, we get

$$\frac{3\,k^2 - k^3}{1-k} = \frac{6\,Nen}{f_s\, d^2\, b} \quad \text{.....(2)}$$

Values of k and j for varying values of

$$\frac{6\,Nen}{f_s\, d^2\, b}$$

all of which are known quantities, may be taken directly from Fig. 5.

By taking moments about the centroid of the compressive stresses in the concrete (making the moments of these stresses equal to zero) and solving for A_s', we have

$$A_s = \frac{N\,(e - jd)}{f_s\, jd} \quad \text{.....(3)}$$

To find the compressive unit stress in the outside fibers of the concrete, the following equation, which is derived from equation (1) may be used:

$$f_c = \frac{2\,Ne}{kjd^2 b} \quad \text{.....(4)}$$

If it is found that the numerical value of f_c is greater than that allowed by the design specifications, the method given under Case II for finding the cross-sectional area of the tensile steel reinforcement required, must be used instead of employing equation (3).

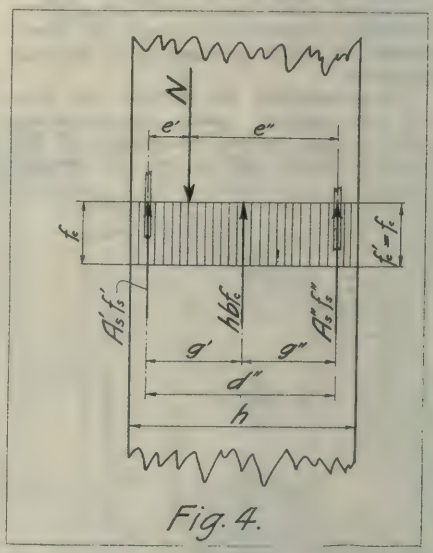


Fig. 4.

Case II. When Both Tension and Compression Reinforcement Is Required. (See Fig. 2.)—

Given: b, d, d', d'', e, e', f_c, f_s, n and N.
To find: A_s and A_s'.

In Fig. 2 is indicated the magnitude and location of the normal component of the resultant of all outside forces acting on the rectangular cross-section under consideration as well as the magnitude and locaton of the resultants of the compressive stresses in the concrete, the compressive stresses in the steel reinforcement, and the tensile stresses in the steel reinforcement, resisting and balancing the outside forces.

By taking moments about the center of the tensile stresses in the steel reinforcement (making the moment of these stresses equal to zero) and solving for A_s', we get

$$\frac{Ne - \frac{1}{2}\,kjd^2bf_c}{f_s'\,d''}\;\frac{n}{n-1} \qquad \text{.....(5)*}$$

in which the unknown values of k, j, and f_s', may be found from the following well-known formulas:

$$k = \frac{nf_c}{nf_c + f_s} \qquad \text{.....(6)}$$

$$j = 1 - \tfrac{1}{3}\,k \qquad \text{.....(7)}$$

$$f_s' = nf_c\,\frac{kd - d'}{kd} \qquad \text{.....(8)}$$

By taking moments about the center of the compressive stresses in the steel reinforcement (making the moments of these stresses equal to zero) and solving for A_s, we have

$$A_s = \frac{Ne' + \frac{1}{2}\,kdbf_c\,(\frac{1}{3}kd - d')}{f_s\,d''} \qquad \text{.....(9)}$$

where the value of k is as given by equation (6).

Case III. When Only Compression Reinforcement on "Compression" Side Is Required. (See Fig. 3.)—

Given: b, d', e', f_c, h, n and N.
To find: A_s' and f_c'.

In Fig. 3 is indicated the magnitude and location of the normal component of the resultant of all outside forces acting on the rectangular cross-section under consideration and also the magnitude and location of the resultants of the compressive stresses in the concrete and the steel reinforcement resisting and balancing the outside forces.

By taking moments about the center of the steel stresses (making the moments of these stresses equal to zero) and solving for f_c', the result

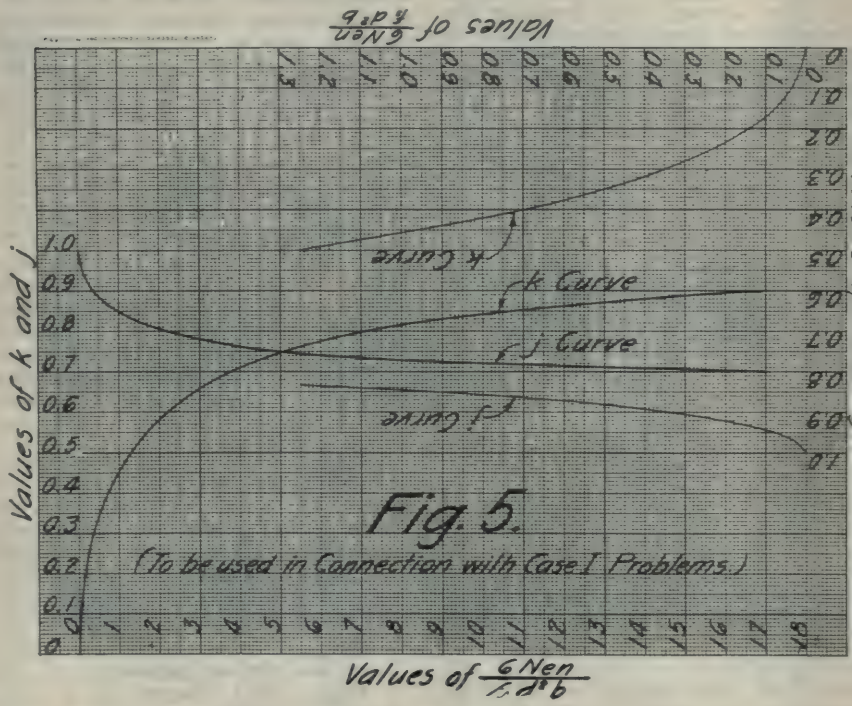
$$f_c' = \frac{Ne' - \frac{1}{2}\,hbf_c\,(\frac{1}{3}\,h - d')}{\frac{1}{2}\,hb\,(\frac{2}{3}\,h - d')} \qquad \text{.....(10)}$$

Taking moments about the outside compression fiber of the concrete on the "Compression" side and solving for A_s', we have

$$A_s' = \frac{N\,(e' + d') - \frac{1}{6}h^2b\,(f_c + 2\,f_c')}{(n-1)\,d'\left[f_c\,\frac{h-d'}{h} + f_c'\,\frac{d'}{h}\right]} \qquad \text{.....(11)}$$

where f_c' has the value obtained by applying equation (10).

If the numerical value of f_c' is greater than f_c, the equations given under Case IV must be used for finding A_s' instead of equation (11).



Case IV. When Compression Reinforcement on Both "Compression" and "Tension" Sides Is Required. (See Fig. 4.)—

Given: d'', e', e'', f_c, f_c', g', g'', h, n, and N.
To find: A_s' and A_s''.

In Fig. 4 is indicated the magnitude and location of the normal component of the resultant of all outside forces acting on the rectangular cross-section under consideration and also the magnitude and location of the resultants of the compressive stresses in the concrete and the steel reinforcement resisting and balancing the outside forces.

By taking moments about the center of the compressive steel stresses on the "tension" side (making the moments of these stresses equal to zero) and solving for A_s', we get

$$A_s' = \frac{Ne'' - hbf_c g''}{(n-1)\, f_c\, d''} \quad \text{.....(12)*}$$

Similarly

$$A_s'' = \frac{Ne' - hbf_c g'}{(n-1)\, f_c\, d''} \quad \text{.....(13)}$$

*NOTE: Although not so indicated in the figures, to avoid unnecessary complications, the decrease in compressive concrete area due to the compression steel was taken into account in the derivation of these equations. The equations not marked with an asterisk were not affected by this decrease.

Reinforced Concrete Under Shock

Editorial in The Canadian Engineer for Nov. 27.

Accounts of the behavior of the reinforced concrete buildings in the recent Japanese earthquake disclose some astounding facts with respect to the resistance to shock of the material of these structures. It might perhaps have been expected that under the heavy impact and vibration effects of an earthquake, a friable material such as concrete would, although reinforced, break down and bring about destruction of the building. However, such did not take place. It has been reported by competent engineer observers that reinforced concrete structures, or portions of structures composed of this material, stood up remarkably well under the severe test. Of course a cracking inevitably occurred at certain junctions of members or wings of buildings, but the damages sustained were found to be surprisingly small in consideration of the attacking forces. It is, therefore, being recommended by engineers familiar with Japanese conditions that reinforced concrete as well as structural steel be considered as legitimate material for the structural members of important buildings in the earthquake area.

Another exemplification of the high power of resistance of reinforced concrete to shock is seen in the behavior of a number of jetties in England which have been subjected to collision by steamships. Recently, a reinforced concrete pier at Tilbury was struck by a vessel of 8,723 tons at one of the main cylinder piers of the river face of the structure. Although the stern of the vessel was damaged to an amount of some $9,000, the jetty was damaged only locally. The cylinder pier which bore the brunt of the collision was pushed inwards and broken at the points of contact with the horizontal members, but sprang back to within 2½ in. of its original vertical position. The adjacent piers and bracing transmitted the load remarkably well so that the damages were confined very largely to the two panels of the jetty adjoining the pier which was struck.

Similar behavior is reported in connection with collisions at Port Talbot and Purfleet. In case of the latter jetty, a steamship penetrated to a depth of about 13 ft., but without destroying the cohesion of the members around the gap or impairing the integrity of the structure as a whole. These and similar instances lead one to believe that concrete in a reinforced condition possesses elastic properties altogether different from those possessed by plain concrete. It might perhaps be expected that the concrete surrounding the steel would be shattered in very much the same manner as a member of plain material, but so intimate is the effect of the steel on the concrete that the two appear to behave elastically in a manner much more like steel than like concrete.

Roof Types and Surfaces for Industrial Buildings

A General Discussion in The Architectural Forum for September, 1923

By WALTER F. BALLINGER

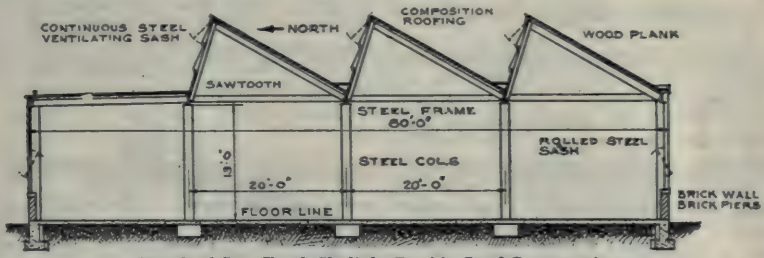
President, The Ballinger Company, Architects and Engineers, Philadelphia and New York

A thorough treatment of the subject of roof types and roof surfaces would require the compilation of a vast amount of detail showing many ramifications of modern practice. To encompass this field in a brief space requires much elimination and a rather cursory treatment of the major problems involved in roof design. The principal points discussed are structural types, roof materials and surfaces, condensaton and the prevention of leaks.

Flat Roofs.—The simplest form of roof construction is a flat roof supported on beams, girders and columns. Either wood alone in heavy mill construction, or wood beams on steel girders and columns, or all-steel construction is used in this type. Wood plank generally forms the structural surface. Due to the many columns necessary to support an extensive roof of this kind, it is employed in industrial work mostly for small or temporary buildings or for warehouses in which the material to be stored does not require large, unobstructed floor areas. It is, however, frequently used in concrete construction of the beam and girder type. Flat slab concrete construction is essentially the same structurally.

"A" Roofs.—To procure longer spans between columns, trusses of various types are employed, the commonest being the "A" type, giving a roof of distinct pitch in two directions, and the Howe truss, giving a more or less flat roof. The "A" type truss is commonly used without columns for spans up to 60 ft. and occasionally for greater widths, and is built of either wood or steel. The relatively sharp slope of this roof, when used with monitors or other ventilators at the ridge, assists in ridding a building of heated air or obnoxious fumes that are lighter than air, as the gases rapidly seek the highest point and pass out through the openings provided.

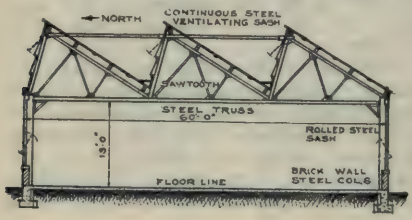
Where high humidity must be maintained within a building, as in many textile mills, and where condensation of the moisture with the resulting dripping must be avoided, it is important that there be no obstructions to the free passage of the air along the under side of the pitched roof from the low point to the ridge. Should the moisture-laden air be interrupted in its flow by a purlin placed horizontally, for example, the air caught by the pocket thus formed would tend to give up its moisture due to the prolonged contact with the cool roof. The water condensed at this point would drip from the roof and purlin, while the air after cooling would tend to descend out of the pocket to be replaced by more moisture-laden air, the process constantly repeating itself. By keeping the heated, moist air rapidly moving to the ridge and out of the ventilators, much of the condensation is avoided until the air is actually outside the building.



Standard Saw-Tooth Skylight Roof in Steel Construction.

Roofs of Large Area.—When a structure of considerable area is to be roofed, columns become necessary. To combine a series of "A" trusses would result in deep valleys over each

row of columns. Consequently, where long spans are required with columns at relatively remote intervals and when ventilation is not a primary requirement, the Howe truss or some one of its related types is used. Clear spans up to 80 ft. are common with this truss, and greater widths can be bridged if the cost is not too great a factor. A characteristic of this type of framing is that it requires additional height in a building at the eaves in order to accommodate the truss above the clearance established for the lower chord. Roughly speak-

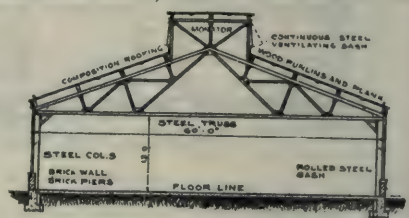


"Super-Span" Saw-Tooth Roof.

ing, the height of a Howe truss is one-eighth of its span; hence for a 100 ft. span the upper chord bearing the roof would be approximately 12 ft. above the lower chord. This adds to the cost of the wall construction, and it adds materially to the cost of heating and conditioning this extra volume of air, whenever such is necessary.

Monitors.—Both the "A" truss and the Howe truss are commonly surmounted by monitors which take various forms. The most frequently used monitor consists of two parallel rows of glass on either side of the ridge, with a pitched roof above them, the slopes of the monitor roof being approximately the same as for the main roof. Sometimes a straight roof, pitched to drain in one direction only, is employed on the monitor. A variation of this monitor consists in having its roof surfaces pitch downward to the center, forming a V, the bottom of which is generally at the same level as the ridge of the main roof. The purpose of this reversed form is to eliminate any air pocket, and to assist in the complete removal of moist air or undesirable fumes. As will be noted, this kind of monitor places the windows at the highest point. A modification of this kind of monitor is formed by continuing one surface of a pitched roof beyond and above the ridge for a short distance, and connecting this false ridge with the other roof surface by means of glass sash set at a slope of approximately 3 in. to the foot away from the vertical. The resulting monitor is thus one-sided, combining the characteristics of a saw-tooth roof with an "A" truss framing. The glass in these monitors is generally faced only to the north, as in sawtooth buildings, to eliminate sun glare and heat, but sometimes it is placed in alternating directions in every other bay without regard to compass points. In this case the function of the monitors is primarily that of ventilators.

The "High and Low Bay" Type.—The "high and low bay" roof is useful where long spans are desired with monitor lighting. In this type, the building is spanned crosswise with a series of flat or Howe trusses spaced at regular intervals. Beginning at one end of the building the roof is placed at the level of the bottom chords. The roof between the first and second truss is at the level of the top chords and rests upon them. The roof between the second and third truss is again placed down at the bottom chord, and so on down the



Monitor Roof in Steel Construction, Giving Good Light and Ventilation.

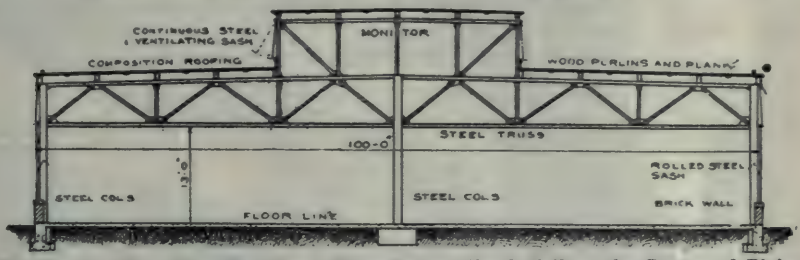
length of the building. The vertical faces of each truss carry ventilating or rigid steel sash, so that every other pair of trusses constitutes a monitor with glass sides. By this simple scheme the depth of a Howe truss is utilized with a minimum of waste space requiring heating and air conditioning.

Sawtooth Roofs.—Monitors may function both as ventilators and skylights. Under certain conditions the admission of direct rays of the sun through monitors is objectionable because the illumination of the interior is very "contrasty," with bright, sunny spots and dark shadows. Furthermore, skylights admitting the sun's rays act as greenhouses; that is, the heat of the sun enters, which is often

undesirable, especially in summer and in plants that are otherwise overheated. To overcome these objections, sawtooth roofs are used, consisting of a series of parallel skylights facing the north, and having the glass so placed as to receive none of the direct rays of the sun. The glass may be placed vertically, but a greater lighting efficiency results from sloping the glass to the angle corresponding to the deviation of the sun from the meridian at the summer solstice.

Sawtooth roofs are constructed entirely of wood or may be entirely framed with steel or concrete. Generally each valley is supported by a row of columns spaced from 16 to 25 ft. apart, though greater spacing may be obtained with ordinary I-beams of sufficient depth. To get long spans several methods are employed. A Howe truss may be used in back of the glass in a perpendicular position from the peak of the skylight or sloped to correspond with the angle of the glass. Owing to the depth required for this truss it is practicable only up to 60 or 70 ft. The use of a Howe truss transversely to the sawteeth and beneath them permits of somewhat longer spans, but the cost is greatly increased. This is because the truss requires from 8 to 12 ft. of extra height to the building, and from 8 to 12 cu. ft. of wasted space to be heated and conditioned for every square foot of floor area.

The "Super-Span" Design.—An economical method of framing sawtooth roofs without columns has been developed and patented by the writer and is called "Super-Span" construction. The system employs both longitudinal and transverse trusses. In back of the glass is an ordinary truss as just described, which supports the roof longitudinally for distances up to 60 or 65 ft. These trusses in turn are supported (at 60 ft. intervals) by a heavier transverse truss, whose bottom chord is at the same level as the valleys and whose top chord extends outside the "sawteeth" connecting their peaks one to the other, the structural members of the skylights becoming the struts and braces. It is somewhat like an ordinary bridge truss except that the angles of the web members are not equal in each pair. Reference to the accompanying illustration will clarify this point. With this system of framing, spans of 100 ft. in width (transversely to the skylights) and of any length whatever are constructed at only slightly greater cost (for the building as a whole) than for a sawtooth roof supported on columns under each valley. If widths greater than 100 ft. are to be roofed, a row of columns about 60 ft. apart is required for each additional 100 ft., giving a column spacing of 60 by 100 ft.



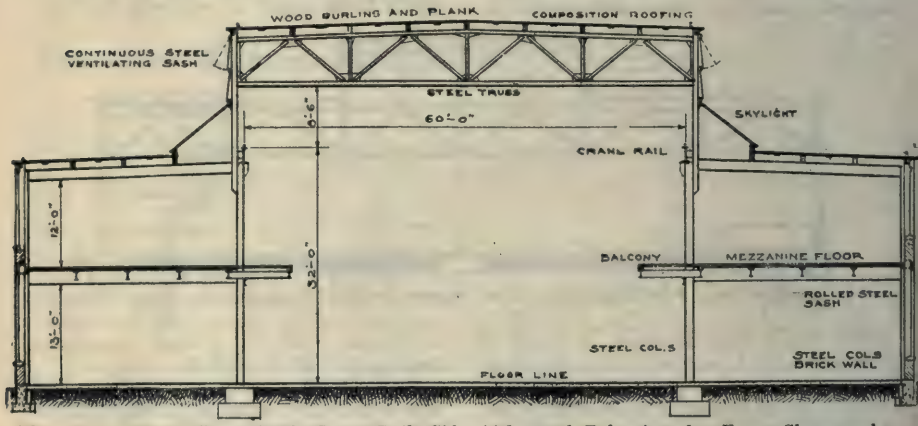
Wide Monitor Type, Providing Space Above Bottom Chord of Truss for Ducts and Piping.

Arch Roofs.—A fourth kind of roof framing is the wood or steel truss of arch form, suitable for spans of considerable length where very light roof loads are to be carried. They are frequently used for garages or small armories, but when built of wood are not highly considered by fire protection engineers on account of the small dimension lumber used to build up their lattice webs and laminated chords. Two types may be distinguished, the first consisting of a curved truss built up of wood, in which the upper and lower chords are both arched and are nearly parallel to each other. The web members are placed much the same as in a Howe truss. A steel or iron rod in tension connects the ends of this truss like the string to a bow, and takes care of the thrust of the roof. The usual spans for this roof range from 60 to 100 ft. The second type, which is generally built up of laminated wood members, has an arched upper chord

and a flat lower chord, the whole forming the segment of a circle. The latticed web members of this truss are arranged according to a rather complex system, and several effective methods of construction are controlled by patents. Spans as great as 100 ft. have been bridged occasionally with these segmental trusses.

Skylights.—Skylights are used on all types of roofs, sometimes even in conjunction with monitors. There are two kinds—those that have their glass near to and parallel with the roof surface, called "flush" skylights, and those having their glass in various arrangements on frames extending well above the roof surface, called "standing" skylights. Flush skylights are used principally on pitched roofs of distinct slope where their shallow frames are not likely to be flooded, and function almost entirely as windows rather than as ventilators. Standing skylights take many forms, but very commonly have tops shaped like a hip roof with plain or ribbed glass held in light metal or wood framing. The sides of the skylight may be of glass or metal, but very frequently have ventilating sash like that used in monitors. When ventilating sash is not used other forms of ventilators are employed, as these skylights are mostly used over elevator and stair wells or light courts through which warm and foul air rises and is removed.

Structural Roofing Materials. — Turning now from roof structure to the materials of construction, we face an even broader field. First to be considered are the materials used for the structural roof itself—the substances used to span the spaces between trusses or purlins, on which the upper waterproof surface is placed. Wood plank is largely used because it is inexpensive and is a fairly good non-conductor of heat and therefore helps to reduce the heat loss from the building and to minimize condensation on the under surface. It is objectionable in several ways, however, the principal disadvantages being that it will rot, and that it is combustible. The tendency to decay may be counteracted by various chemical treatments, some of which are sufficiently inexpensive to warrant their use. Wood may be used in the presence of many chemical fumes that would destroy metal or masonry construction. Concrete is much used for structural roofs where the rest of the building is of concrete. It has many merits, particularly for roofs of flat pitch. Various systems of construction are used, employing gypsum tile, metal tile, burned clay tile and the like, or using ordinary beam and girder or flat-slab construction. Concrete requires some condensation under certain conditions. Gypsum in various forms is coming into wide use because it is a non-conductor of heat and therefore reduces condensation to a minimum. In this respect it is about as effective as wood. Gyp-



Three-Bay Monitor Type, With Crane Rail, Side Aisles and Balconies, for Forge Shops and Heavy Manufacturing

sum is non-combustible, permanent, and of light weight, and is easily handled. Except under acid conditions, gypsum is generally preferable to wood plank and costs but little more.

Gypsum Surface.—There are several methods of laying a gypsum roof. One method employs a roof tile or small slab set in angle irons or inverted T's. Another uses a much larger slab of gypsum containing suitable reinforcement. A third uses a stiff gypsum board resembling a prepared plaster board which is rested on iron framework of the type used to support gypsum slabs. Reinforcing steel is placed above this board, and then a gypsum cement is poured over the whole, the board acting as a form that is left in place. A similar method uses a temporary wood form as for flat-slab concrete work, with light I-beams at proper intervals. Gypsum cement is poured over wire reinforcing as in the last case.

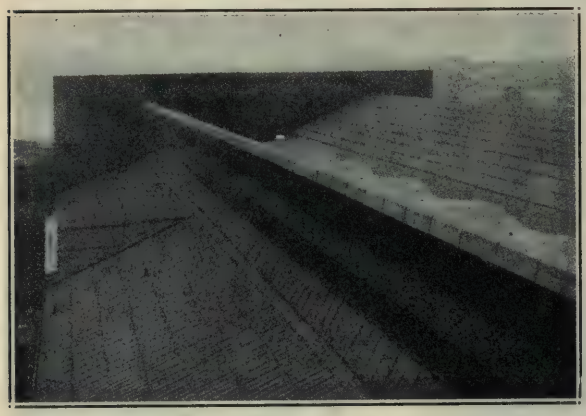
Corrugated Iron.—There are a number of substances which not only form the structural roof surfaces but also have suitable weatherproof surfaces which are used without top membranes or other surface treatments. Commonest among these is corrugated galvanized iron, which is much used for low cost temporary structures. It is probably the lowest in first cost of any roofing material. Its use is limited by the fact that it will rust in time, that it is attacked by many gases and chemical fumes, and that it is an excellent conductor of heat. This last characteristic connotes that much heat is lost through the roof in winter and that it will be unduly hot in summer sunshine, and furthermore that under humid conditions moisture will rapidly condense on its under surface on cool days. To overcome the deterioration of galvanized iron and yet retain its relative economy and simplicity, it now comes with both surfaces (and even the edges) covered by one or more layers of asbestos paper firmly cemented to the metal. A great improvement in the life and usefulness of the material has been achieved by this process, although the conductivity has not been lessened sufficiently to eliminate this factor.

Interior of Ardross Worsted Co. Weave Shed, Philadelphia. "Super-Span" Saw-Tooth Roof, Spanning Room 88 ft. by 168 ft. Note Ventilating Sash and Operating Device. The Ballinger Co., Architects and Engineers.

Asbestos Roofs.—Corrugated asbestos or even plain asbestos sheets are used in much the same manner. This material is less subject to deterioration even when exposed to many

chemical fumes. It has low heat conductivity and is therefore less liable to permit condensation, although the thinness of the sheets does not afford sufficient insulation when there is any very great difference in temperatures to be combated.

Corrugated Zinc.—Corrugated zinc is now being placed on the market and offers certain merits useful in special cases. Zinc will not rust, and therefore a roof of this material will have a high salvage value, suggesting its use for buildings of only a semi-permanent nature. It has a low melting point and would be destroyed by a fire in close contact with it. It will resist corrosion of some fumes, but is readily attacked by other chemicals. Like iron roofing, it is highly conducive.



Detail of V-Shaped Monitor Roof, Showing Drainage and Cement Tile Covering.

Wire Glass Roofs. — Corrugated wire glass is similar to the types of material just mentioned, having aside from its translucency the qualities of permanence and resistance to practically all forms of corrosion. If securing daylight were the prime requisite of a structure, there is no reason why the entire building might not be made of glass supported on a steel framework. The disadvantages of glass are its high conductivity, its weight, and its brittleness. Though wire glass will not shatter under an impact, the cracks that result will admit water unless cemented. The motion of a building, due to temperature changes, wind pressure, or internal stresses, requires a flexible setting for the glass, which is now entirely practicable.

Concrete Tile.—Concrete tile of fairly large dimensions are now on the market and may be used alone directly on the steel channels whenever air leakage and condensation are not factors, as in boiler houses and foundries. They are adapted only to steep pitch roofs, but require no further surfacing. Wood, concrete, and gypsum roofs require the protection of a waterproof or rain-shedding surface material to give satisfactory results. On roofs of steep pitch, materials that will shed water are sufficient, while on flat or low pitch roofs a waterproof membrane must be constructed, on which water can stand.

Shingles, Slate and Tile.—Shingles, slate, and tile are the principal water-shedding materials, depending on their overlap and the pitch of the roof to prevent rain from penetrating. Shingles of wood are now seldom used, but prepared shingles of felt paper, of felt with a stone surface, and of asbestos cement are commonly employed in industrial construction. Choice depends on the factors of cost, permanence, fire resistance, and appearance pertaining to any given problem. Slate and tile are somewhat heavier materials, having similar qualities, with like factors governing their choice.

View Showing Beam Forming Top Chord of "Super-Span" Truss, of Weave Shed, Andross Worsted Co., Philadelphia.

Copper, Tin and Zinc.—Metals are

also used on roofs of steep pitch, copper, tin, and zinc being the materials most employed. The metal sheets are crimped together at the edges and are soldered at all flat seams. The vertical seams are frequently left standing. Copper possesses ideal permanence under most conditions, its use being restricted largely by the expense. Tin is the least expensive in first cost, but requires regular painting to protect it from corrosion. Zinc is quite new to this purpose, but it appears to have a place between copper and tin, and will doubtless prove satisfactory when its possibilities and limitations are thoroughly understood.

spread to form a protective surface, keeping the sun from melting the binder.

The characteristics of the several materials employed vary slightly. Pitch has a lower melting point than asphalt, and will melt under a hot sun and gradually work down the slope of a roof unless protected by gravel or slag. Asphalt does not need this protection and may be left black, although this practice is not desirable on sawtooth roofs, as a light surface greatly increases the amount of light entering the adjacent skylights. The webbing may be of felt paper impregnated with pitch or asphalt or asbestos felt impreg-

Saw-Tooth and Monitor Type Roofs Covered With Interlocking Cement Tile and Glass Insert Slabs at Plant of Maxwell Motor Co., Detroit.

Pitch, Asphalt, Paper and Felt.—Flat roofs or roofs having valleys where water may collect, as in sawtooth buildings, require that the roof surfaces be made absolutely impervious to water. Pitch or asphalt with layers of paper or felt, and frequently with a surface of gravel or crushed slag, are the materials employed to form a water-tight membrane. The process employed is well known, generally consisting of the application to the roof of a layer of hot pitch or asphalt, over which is a layer of paper or felt, then another layer of binder and another of felt until four or five layers of the tar and three or four layers of the webbing have been laid. All seams are overlapped as each layer is added. On the last coat of tar fine gravel or ground slag is

nated with asphalt. The only choice in the use of gravel or crushed slag is to get the cheapest, as either is satisfactory.

When flat roofs are used to walk upon, as for play areas or for promenades, it is best to provide a more durable wearing surface over the waterproof membrane. Concrete may be used for a low cost job, if expansion is provided for; otherwise quarry tile or small slates are set in asphalt.

For temporary buildings, and where first cost is an important consideration, prepared roofing made of layers of tar and paper or felt are on the market in great variety, many having a stone surface rolled on. They are laid with a cemented lap, and if properly laid are practically the

same as a built-up roof of equal weight. However, the human factor counts in this work to such a degree that a more permanent roof generally results when there are three or four laps in the thickness of the roof than when there is only one; in other words, a built-up roof may have imperfect laps on one or two layers and still be tight, but a prepared roof depends entirely on the tightness of a single lap. On the other hand, roll roofing may be economically laid on sloping roofs where the tightness of the lap is of less importance. Vertical surfaces, such as the ends of monitors and sawtooth skylights, are generally covered with metal or with prepared roofing or shingles.

Heat Insulation.—To eliminate the difficulties attending the loss of heat through roofs, with particular concern for minimizing condensation on the inner (and in some cases, upper) surface of roofs, it is occasionally necessary to interpose a layer of insulating material between the structural roof and the outer surfacing material. Several substances are prepared for this purpose, cork being very commonly utilized. Fibrous mattings or compressed boards are efficient in varying degree. If extreme conditions are being contended with, drip gutters must be placed beneath windows, under beams, and at all places where experience shows drops of water will collect. To avoid condensation on windows it is necessary to use double-glazed sash.

Flashings of Leakage.—The final point in a satisfactory roof is the flashing at all interruptions in the plane of the roof. These points should be observed: First, the flashing should be of a permanent and non-corrosive material. Second, it should be set in a flexible manner, particularly with wood plank roofs so that the shrinkage of the wood will not tear the flashing. Third, flashings should be carried above the highest point to which water can collect before overflowing its barriers in case the drains are choked or are of insufficient capacity. This means that the flashings should extend at least as high as the "crown" of a flat roof, and preferably to the level of some emergency overflow, such as a series of "weep holes" extending through the parapet walls.

Elastic Wall Primer Is Good Paint Base

American Builder for November contains the following:

Care in the preparation of walls for their coatings of paint is highly necessary if the best final results are to be obtained. The preparation of the walls by proper application of elastic wall primer becomes an important operation.

Elastic wall primer is used to seal very porous surfaces—in the language of the painter, to "stop suction"; to facilitate brushing properties of first coat over surfaces which are quite porous; to prevent lime burns.

The ordinary wall will not require any sealing other than that afforded by the undercoat, but walls where the porosity is greater than usual require a product which will seal the wall and reduce the suction. This can be done by applying a coat of the primer straight, or mixing it with the paint to be used on the next coat. The latter is the more desirable method, in that the addition of material used on a subsequent coat tends to offer better conditions of amalgamation between the coats. However, there are instances where a straight priming coat has its advantages, especially on an extremely porous wall, or where the wall is new and additional precautions are taken to prevent lime burns.

For porous walls, it is advisable to add a primer to the first coat so that the liquid portion in the paint is increased, and it is possible to brush the paint more easily and sufficiently without having it penetrate the wall too rapidly. If the paint penetrates too quickly, it cannot be applied evenly and so that it will not show brush marks.

The following suggestions apply to the use of elastic wall primer:

1. For the sealing of fresh walls where protection against lime burning is desirable, use of coat of elastic wall primer straight.

2. For the sealing of walls which are porous, the addition of one to two quarts of elastic wall primer per gallon of undercoater or flat wall paint.

3. On walls which are very porous, it may be necessary to use elastic wall primer straight as a sealer coat.

The Construction Outlook for 1924

Opinions of Prominent Contractors Throughout the Country Collected and Discussed in "The Constructor"

By IRA L. SMITH

The construction industry admittedly is now as greatly in need of an insight into its immediate future as at any time in its history. The eccentric season through which it has just passed naturally creates doubt concerning what reactions may be expected to develop.

A campaign was launched last January by the Associated General Contractors which had as its purpose the curtailment of construction operations so that a "mad market" for materials and labor might be avoided while the country began to reduce the volume of delayed building activities. While the range of influence exerted by this campaign is so nebulous that it can not be reduced to the material form of words and figures, it is certain that prices of materials and costs of labor did not rise to the prohibitive heights.

Having rushed rather excitedly through the first months of its freedom from war's reactive economic handicaps the construction industry finds in reaching the threshold of winter that it has a chance to indulge in a breathing spell and contemplation of the future.

This contemplation rests mainly upon the probable trend of prices of materials, costs of labor and demand for construction through the coming winter and the resumption of construction in force next spring.

The unprecedented character of events through which the industry has been passing makes it necessary that the broadest possible range of opinion be brought to bear in an attempt to analyze the past, survey the present, and anticipate the future. Under more ordinary circumstances it would be comparatively easy to trace the working of natural laws and the effect they would have upon construction activities during the coming season, and the word of the first student of the situation might well be accepted as correct, for there would be little variation in opinions.

As matters stand, however, it becomes necessary, if the industry is best to be served, to strike out and gather thoughts from observers far and wide, detecting the points where these thoughts coincide and casting approximations about the future from these points.

A survey of expressions of thought by analytical minds both within and outside the industry apparently develops the fact that building costs next spring will rest on approximately the same level they occupied as the first indication of a seasonal decrease in operations became evident this year.

As to the volume of construction to be expected next year, it seems to be generally conceded that the situation will closely resemble that which existed at the beginning of the season just closing.

More immediately, the consensus of opinion indicates a slight reduction in building costs through the winter, induced by the relaxation in operations brought on by the advent of cold weather.

Close observers, however, declare an unusual amount of work will be undertaken for completion early next year. Among the conditions being cited as conducive to this situation are: reports by architects indicating a large amount of work in immediate prospect; good crops; conditions close to normal in many respects; seeking of information by prospective home builders who evidently are ready to "go ahead"; lower money rates; increased mechanics' wages; general confidence; certainty of transportation as developed by performances during the "peak" wages in demand for car movement; and a general sufficiency of money in building and loan associations.

Existence of these favorable conditions is certified by results of a questionnaire recently circulated among retail building supply dealers, which, according to a report made

three weeks ago, brought out the fact that no slump in construction activities was in sight.

This group of thoughts, presented exclusively in this issue of the "Constructor," will offer a valuable basis for working toward formulation of a policy which will dictate the restraint or impetus which should be exercised over building operations. This dictation is necessary to aid the natural laws in leveling the peaks and filling the valleys which otherwise may appear in the curve representing the variations in volume of activities shown during the coming year.

These expressions of opinion, made exclusively for The Constructor by the foremost general contractors and other observers who have opportunities to become intimate with conditions, present the basis for intelligent and accurate anticipation of the trend which construction activities may be expected to take during coming months.

Leaders of the construction industry likely will find themselves confronted next spring by conditions quite similar to those existing early this year, and will be called upon to decide whether advocation of a curtailment of operations again will be necessary. Several of the observers who here express their thoughts have devoted themselves specifically to discussion of this subject, and the general thought seems to be that at least a spirit of caution will have to dominate when activities begin to increase following the seasonal drop brought on by winter.

H. W. Baum, H. W. Baum Company, Salt Lake City—The situation in this territory, that is to say, the Intermountain District of which Salt Lake is the geographic center, is just beginning to reach a point where the volume is anything like normal. A careful survey of the situation would indicate that curtailment at this point is not necessary right now and it is not likely that the volume will be sufficiently increased to make it necessary in the immediate future.

Until the last three months the territory of which Salt Lake is the center has been decidedly behind in the volume of building and construction business when compared with almost any other section of the United States. There is, to no appreciable degree, speculative building in this district and, aside from the normal housing program, there is nothing that approaches it. Of course the resulting business is subject to the effect of the markets in the larger production centers where a great deal of manufactured material is prepared for the structures erected in this section. Also the equipment which is used in carrying out the work.

It is our opinion that there is not likely to be a situation arise during the coming year which will require curtailment in any substantial form in the construction activities of the intermountain district.

James Baird, George A. Fuller, New York. — Judging from the permit record covering the period of June, July and August, there is assurance of the country in general having a large building program for this coming year; consequently, I look for a very serious labor shortage again in the spring. There is so much speculative work contemplated that I do not think it would be desirable to encourage it too much. Personally, I would prefer to see a reasonable amount of the work postponed until we are assured of a more ample supply of labor and material.

L. C. Wason, Aberthaw Company, Boston.—In our canvass for new work we find a considerable amount of industrial construction in view, most of which is held up due to unsettled business conditions and high building costs.

The prospect now is that the number of industrial contracts awarded this fall or winter will be small, and that the contemplated work will not go ahead until business condition settle or construction costs drop.

My suggestion is that we start a "Build Now" campaign, and do everything possible to promote building this winter, emphasizing the fact that winter construction, handled by an experienced contractor, is as satisfactory as work built in the summer time. As far as the cost is concerned, the difference is very little, if any.

When buildings go up in cold weather labor is more plentiful and consequently more efficient, and it is also possible to make advantageous

purchases of construction materials, due to the slow markets.

My forecast for the future is that there will be slight reduction in building costs through the winter, due to softer spots in the material markets and increased labor efficiency, but that the usual spring building activity will bring costs back to about the present level. Therefore, a "Build Now" campaign for fall and winter is in the line of stabilizing the industry and giving the investors a square deal.

Sumner Sollitt, Sumner Sollitt Company, Chicago.—Undoubtedly, in my opinion, much work which would otherwise have been started in the early part of the current year was delayed on account of the publicity given through various channels that men and materials were not sufficient to take care of the vase amount of construction which seemed to be necessary. Much of the work so delayed is still in contemplation. The costs on what work was done were, in my opinion, far too high.

Men available for construction are not now plentiful. I thoroughly believe that no propaganda at the present time, either for obstructing or accelerating the desire for contemplated construction, is necessary. Moderate price residential work will go ahead in volume just as soon as owners are sure they can obtain value received. Building construction on railroads is becoming more active and certainly much is contemplated. Manufacturers seem to have had a good year and expansion seems to be still their desire.

In the large centers, much high-priced property is still suffering on account of the high cost of office building construction. I thoroughly believe that sufficient of this construction will be started so as to allow our business to assume a busy trend and keep the industry in a healthy condition. The advice of architects and constructors to their clients and customers that the time has arrived for them to proceed with their needed buildings will have sufficient effect at the present time to start all the work that is necessary.

W. F. Austin, W. E. Wood Company, Detroit.—It would seem to us, from our very limited knowledge of the situation, that the safest plan would be to advocate that for the next six months, at least, the building construction be confined to those structures most urgently necessary. Doing this not with the idea that costs may be lower after that period, but with the thought that unless something of this kind is done costs will again reach the point where a general let-up and universal discontinuation of construction operations will be the result. The condition of transportation, the shortage of skilled workment in some of the branches of the construction industry, not to mention any of the other features in the problem, will accelerate the cost if the demand increases materially in this territory.

A. S. Downey, A. W. Quist Company, Seattle, Wash.—It would seem that the move taken last winter to curtail somewhat building construction was a wise decision. Whether or not the tendency towards normal conditions has come about from this curtailment, it is apparently true that conditions have materially improved and we are not confronted at the present time with the possibility of any material advance in prices.

Just what will be the outcome of the labor situation, it is very hard to forecast. It is possible that the high increase in wages of skilled labor may tend to bring more of the younger men into this line.

It would seem, however, to the writer that further careful study and consideration should be given to our immigration problem. It would seem wise to enact such legislation as would permit more of the class of immigrants entering the country who would contribute to the ranks of real labor.

Taking everything into consideration, it would seem a wise policy at this time to encourage building construction so that we may gradually bring our building program to meet the present demands.

Henry Ericsson, Henry Ericsson Company, Chicago.—In dealing with the question of construction activities during the coming year, I must confine myself only to Chicago territory, as we have not done any work outside of the same since the Landis award went into effect, and therefore can not give any opinion about the rest of

the country. There has been no curtailment in the building business in this territory in the last year because of the shortage of apartments and dwellings; even office space has been scarce at a reasonable rent. This combination has created an opening for construction work and of course the cost of same has been high, so high, in fact, that I can not see how some buildings can pay a fair interest on the investment. A considerable part of the high cost of building in this territory is caused directly by the inefficiency of our mechanics; for instance, we are paying the bricklayers and plasterers twice as much now as we did recently, and these high priced mechanics give us only about one-third of the work they used to give prior to the raise in wages. That alone accounts for more than half of the present high cost. If it was possible to get back the efficiency in the industry we would be able to make a very substantial reduction in our contract price, and that would induce owners to continue building for some time, as there is a desire among the tenants, of all classes, to move into better quarters than many of them now occupy.

I contend that the price per hour paid our workmen does not make near as big a difference in our estimate as the inefficiency does, and this inefficiency is a difficult proposition to estimate, because as long as there is rising wages there is also a decrease in efficiency.

We have, until now, been busy estimating buildings, but in the last few weeks we noticed a considerable decrease. Judging from that, the future is not as bright in this territory as it might be. I think this is a natural consequence of the rush that we have had in the last two years, and I hope it will tend to stabilize the industry on a more firm basis and it will show our mechanics that a fair day's work should be returned for a fair day's pay.

We are operating under the Landis award and have had no strikes or any trouble in the last two years. I hesitate giving any opinion about the coming year, except it looks to me that the worst of the rush is over. This is only my private opinion, and I may say that I have been wrong for two years, so I may be wrong again. The after-affect of the war had a very peculiar influence on things in general. It seems to me that everybody is having more money and lives on a higher plane than before the war; this creates a demand for more new buildings than was required before the war. That is one of the reasons for the building rush in the past and it may be the reason for its continuation for another year or two.

S. B. Haux, The American Construction Co., Houston, Texas.—It is my observation in this locality that further curtailment of building operations is essential to the good of the cause, due to the unprecedented demand of labor.

Extensive building operations, especially applying to projects of investments, have created a condition in the labor field where a great many contractors are paying large bonuses to the different crafts, thereby demoralizing the entire profession.

The only method I see of overcoming this practice, both of the contractors and of labor, is curtailment of the entire program to such an extent that the supply will equal or exceed the demand.

Otto M. Eidlitz, Mark Eidlitz & Son, New York.—I believe that wages are probably fixed for the next two years, and that the price of building material will vary somewhat during the winter months.

The work that would normally come out to meet the still unsatisfied demand for housing and additional business accommodations, as well as the starting up of the work that has been held up during this year, will make 1924 a big year in the building industry.

T. T. Flagler, The Flagler Company, Atlanta, Ga.—Concerning the advisability of relaxing curtailment previously advocated by the Associated General Contractors of America, would say that, in my view, the answer should be as varied as there are different locations in which construction is contemplated.

It is the duty of the contractor, as I see it, to assemble various materials and employ numerous kinds of labor and combine them all into a structure

to fill some useful purpose. Whether any particular building project should proceed or not, depends on two factors —first, the need of the building, and, second, the cost of the construction of it. Both factors ultimately depending on the same old law of supply and demand, which has been present with us, at least as far as I have been interested in this subject.

The need of construction is pressing in many localities. Many of these localities have abundant labor, which is willing to work reasonably hard for a fair wage, and it is possible to obtain material from local sources, at least at a fair price.

On the other hand, there are other localities where labor has utterly disregarded its duty to produce measurably for its compensation, and where the extraordinary demand for material has enabled producers to charge unreasonable profits in supplying same.

All this, therefore, now boils down to the platitude that in those communities where labor and material are maintained at an artificially high price, building should be curtailed until a shortage of work produces a reign of reason in the industry, and that, on the other hand, those communities which can produce buildings at a reasonable and fair price, should be encouraged to increase their output to a point of satisfying the demand for new structures.

This is a very general view. In particular we are interested in construction only in the South and throughout this territory it is my opinion that further building under present conditions will be profitable to the owners in something like 90 per cent of the territory we cover, and this is the real criterion which should cover the volume of construction.

Archibald M. Woodruff, Third Vice-President Prudential Insurance Company.—At the present time we are having a very large demand for mortgage loans to be secured by complete structures, and we have recently declined a number of applications for construction loans. From the information we have received, it is my opinion that there will be an excessive demand for labor in connection with building construction work for several months at least, particularly in our larger cities.

H. C. Turner, Turner Construction Company, New York.—The year 1923 has been a most difficult one for the contractors seriously endeavoring to perform their work on time at reasonable costs.

The major cause was the bulking of too much building work in one year for the available supply of workmen. When builders bid actively against one another for men, wages naturally go up and production goes down—perhaps due largely to the necessity of employing incompetent men and the consequent lowering of the job morale.

It seems to me contractors are confronted with two big problems requiring solution before reasonable stability in the industry can be found.

First—a campaign of education must be conducted to make clear the great saving which would be brought about by spreading the production of buildings more evenly over a period of years, and also the saving which would be affected by utilizing the entire calendar year. In 1921 and the first half of 1922 we all had idle capital, idle plant and idle men. Their employment then would have prevented the congestion and high costs of the present year. The growth of our population is fairly steady. We should seek a more regular production of buildings—the two are related.

Second—We need to foster the education and training of young men of good character to become building mechanics. Builders have a real responsibility in this direction. The New York Building Congress is setting the pace in this work, and we will secure better mechanics if their employment can be made more uniform throughout the year. Young men want steady jobs as well as good wages.

As to business conditions in the future, most of the factors seem favorable for good business, but we have had a bad wheat situation, disorganizing oil industry and uncertain legislative prospects.

Having in mind the great volume of work offered this past eight months, only a part of which could be

built, it would seem foolish if the country did not give full employment to all competent workmen during the coming winter and year 1924

L. J. Horowitz, Thompson-Starrett Co., New York.—The newspapers in New York City, notably the New York Herald, have commented editorially upon the failure of the effort made early this year to curtail construction. Basing this conclusion upon the fact that the volume of business during August, 1923, and for the first eight months of 1923 exceeds that of corresponding periods during 1922, I believe the conclusions of the editor are faulty.

In the first instance, the effect of the publicity given would not or could not in the ordinary course of events be reflected prior to this time. In many instances the owner had become committed to his building operation and had gone ahead with it too far to allow of stopping. In other words, the evil of not going ahead would prove more serious than going ahead under inflated conditions to which his attention was called.

In the second place, I feel convinced that had it not been for the publicity given to high costs the volume of business during August would have been still larger than it was.

I am of the opinion that conditions have been considerably improved but that the time has as yet not arrived when it can be said that the industry has been stabilized to a sufficient extent to make it prudent for an owner to embark upon a building operation to which he is not committed. There will, of course, be exceptions to this rule. There are some situations which will warrant an owner to proceed notwithstanding high costs, because his needs for space are so great as to overshadow the disadvantage of high costs.

In this connection I want to emphasize my theory, which is that associations who are concerned with the welfare of the building industry would more constructively help that industry if they concerned themselves with overcoming the shortage of labor rather than attempting to get along with the labor available. In other words, it is always wiser to rely upon the service of a surgeon than those of an undertaker. I am convinced that an intelligent effort would result in machinery being invented to overcome to a large extent the shortage in skilled labor.

Only yesterday I received a communication from an engineer in Scotland advising me that a bricklaying machine has been developed there which will, with the aid of two or three men, lay 10,000 to 12,000 bricks a day. I am not prepared to say that this machine will do all that is claimed for it, but I am sure that studying this situation from this standpoint is a step in the right direction.

The President of a Leading Engineering Society.—I am very glad that the construction program was curtailed some few months ago, and while I think that at this season it is not likely to run away, yet I believe that caution is necessary lest the program for the next year be made too ambitious and we start out at the beginning of the 1924 construction season with a bigger program than can be put over, with the consequent result that the precedents will be artificially boosted.

The Comptroller of a Leading Life Insurance Company.—As to the trend of construction activities, I do not see any likelihood that they will be dismissed. I think the country is still behind in its construction program as to buildings used for residence purposes and business buildings. I have no information on factories, as we do not lend on factory properties, but I think it is likely that it will be some time before the building program has reached the saturation point.

H. N. Leighton, H. N. Leighton Company, Minneapolis, Minn.—As to the advisability of relaxing the curtailment of building operations advocated earlier in the year, it is our judgment that this should be done. This statement is based on the impression which has come to us, especially during the past six months, during which time there has been a very pronounced decrease in the amount of work offered for figures, and if anything can be done to counteract this tendency it would seem to be highly advisable.

Progressive Economy in Concrete Schoolhouse Design at Philadelphia

Unit Costs and Details of Construction in Types of 1916, 1920 and 1922 Given in Concrete for October, 1923

Philadelphia school buildings are now erected without the use of any bearing walls, the entire structure being one large frame formed of concrete, encased with brick curtain walls and trimmed with stone, permitting

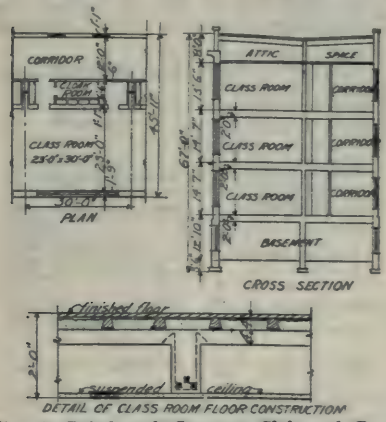


Fig. 1—Reinforced Concrete Slab and Beam Supported by Interior and Exterior Walls. The Type Used in the Oliver Wendell Holmes School in 1916.

great acceleration in actual construction and a reduction to a minimum of the possibility of delay due to labor troubles and delivery of materials.

The use of the reinforced concrete frames has also made it possible to reduce the thickness of floor construction, which in itself has lowered the height of building as much as 36 in. with a reduction in cubical contents of the building and a corresponding lowering of cost. Also, it has made it possible to carry stairs of concrete up with the building, providing a means of travel from one floor to another during construction, which under conditions where steel stairs are used could not be made ready until too late to be of any value to the different contractors.

Some interesting data have been prepared showing comparisons between wall bearing construction and column type made from actual observation and investigation.

Three of the different types of construction investigated are shown in Figs. 1, 2 and 3. Fig. 1 represents the type of school construction built in 1916, the Oliver Wendell Holmes Public School, 55th and Chestnut Sts., Philadelphia, Pa. This type consists of reinforced concrete slab and beams, supported by interior and exterior walls. Flat ceilings formed by plaster on metal lath are suspended from the soffit of the beams. The heavy dead load of the floor and the extreme width of the building should be noted.

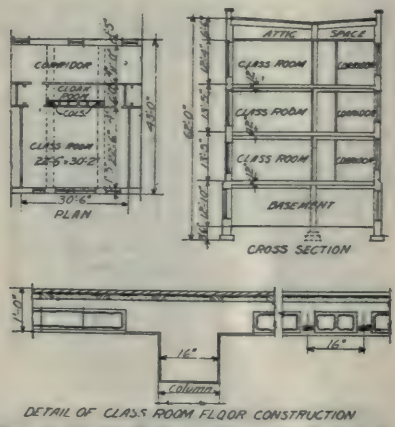


Fig. 2—Light Slab on Concrete Beams and Girders. Suported by Concrete Columns and Brick Bearing Walls. Type Used in William T. Tilden School in 1920.

The gross floor area, 30 ft. by 45 ft. 11 in., is 1,378 sq. ft. Of this, 50 per cent is taken up by the net floor area of the class room, 26 per cent by the corridor, and 24 per cent by the walls, cloak room, etc. The dead load on the floor is 108 lb. per square foot, made up as follows: wood, 4 lb.; fill, 24 lb.; 4-in. slab, 48 lb.; beam, 22 lb.; plaster, 10 lb.

Fig. 2 represents the type of school construction built in 1920, the William T. Tilden School, 70th St. and Buist Ave. This type consists of 2½ in. concrete slab, 4 in. by 6 in. joists and 6 in. by 12 in. hollow tile spanning between concrete girders, supported by interior concrete columns and exterior brick bearing walls. This type of construction permits the omission of interior bearing walls, and lighter

dead load. The gross floor area, 30 ft. 6 in. by 43 ft. is 1,312 ft. Of this 52 per cent is the net floor area of the class room, 26 per cent corridor and 22 per cent is occupied by walls, cloak room, flues, etc.

The dead load of 98 lb. per square foot is made up as follows:

Wood	4 lb.
Fill	12 lb.
2½ in. slabs	30 lb.
Joists, 16 in. o. c.	19 lb.
Tile	13 lb.
Girder	15 lb.
Plaster	5 lb.
Total	98 lb.

Fig. 3 represents a method of construction proposed in 1921. This differs from the construction shown in Fig. 2 in having all loads carried by concrete columns and girders and, also, in the omission of the attic space. This type permits light dead load of floor, estimated at 88 lb. per square foot.

Of a unit 30 ft. 4 in. by 42 ft. 4 in.,

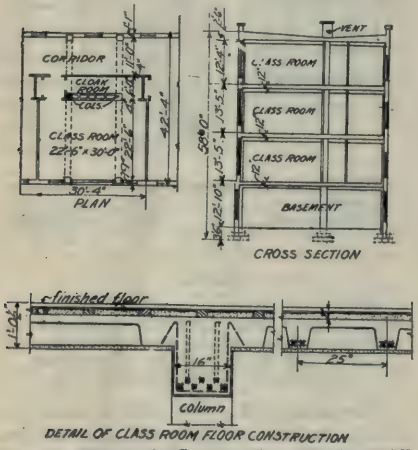


Fig. 3—Type of Construction Having All Loads Carried by Concrete Columns and Girders

having a gross floor area of 1,284 sq. ft., 52.5 per cent is the net floor area of class rooms, 26 per cent the net area of the corridors and 21.5 per cent is taken up by walls, cloak rooms, flues, etc.

The dead load of the floor is as follows:

	Per Sq. Ft.
Wood	4 lb.
Fill	12 lb.
2½ in. slab	30 lb.
Joists, 25 in. o. c.	15 lb.
Steel tile	2 lb.
Girder	15 lb.
Plaster	10 lb.
Total	88 lb.

A comparison of the gross floor areas and cubic contents of the three types shown in Figs. 1, 2 and 3 is given in the following table:

Comparison of Gross Floor Areas

Types	Width of Unit	Depth of Building	Total Area —Sq. Ft.
Fig. 1	30 ft. 0 in.	45 ft. 11 in.	1,377.60
Fig. 2	30 ft. 6 in.	43 ft. 0 in.	1,311.50
Fig. 3	30 ft. 4 in.	42 ft. 4 in.	1,284.

Comparison of Cubic Contents

Types	Area	Hgt. of Bldg.	Cubage
Fig. 1	1,377.60	67 ft. 0 in.	92,299
Fig. 2	1,311.50	62 ft. 0 in.	81,133
Fig. 3	1,284.	58 ft. 0 in.	74,472

An estimate of the saving in cost of the type shown in Fig. 2 as com-

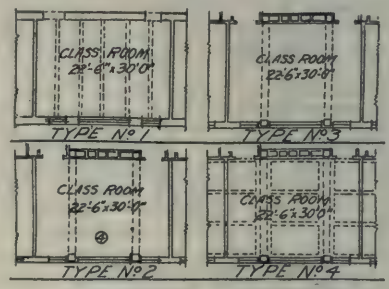


Fig. 4—Four Types of Floor Framing.

pared with the type in Fig. 1 based upon the cubic contents shows a saving in the Tilden School as compared with the Holmes School or Fig. 1, of $55,556.20 at 1920 building prices. This estimate is based upon a difference of 10,986 cu. ft. in a unit of three divisions, the cubic contents being

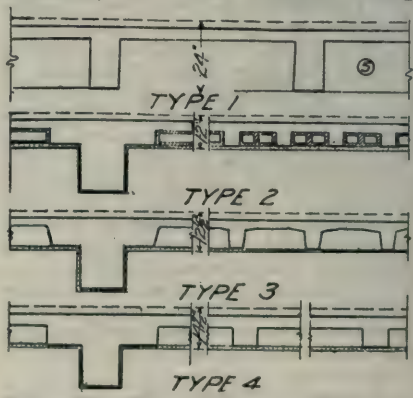


Fig. 5—Four Types of Concrete Floor Construction. Cost Comparison in Fig. 6.

taken from the table above. The saving in cubic feet for one division is 3,662. The saving for 30 divisions being the estimated saving in the Tilden

School compared with the Holmes School, or Fig. 1, is 109,860 cu. ft. Figuring the cost at $0.5057 per cubic foot, the estimated saving is $55,-556.20.

On the same basis of cubic contents, the estimated saving in a 30-division school built according to Fig. 3, compared to the Holmes School, or Fig. 1, based upon the cost of the Tilden School, Fig. 2, is 178,270 cu. ft., which amounts to $90,151.00.

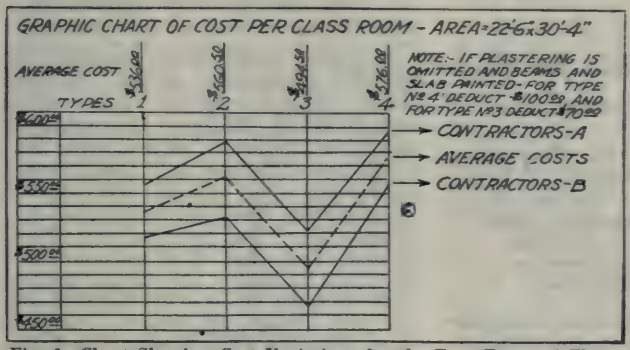


Fig. 6—Chart Showing Cost Variations for the Four Types of Floor Construction.

Fig. 4 shows four types of concrete floor framing. In Type 1, the beams are wall bearing, and owing to the spans, the thickness of the floor construction has to be built 24 in. over all. This type was used in 1916. Type No. 2 shows slab and joist construction with clay tile fillers forming flat ceilings between large girders. The thickness of the floor construction between girders is about 12 in. This type was used in 1920. A somewhat similar arrangement is shown in Type 3, used in 1922. This is a slab and joist construction with removable steel filler. After the removal of the filler, the ceiling is furred and plastered, forming a flat ceiling between the large girders similar to type No. 2. Type 4 shows a 4 in. slab supported by 8 in. by 6 in. beams framing between large girders. With this type plastering may be omitted.

Details and comparison of costs for floor construction are shown in Figs. 5 and 6. In Fig. 5, Type 1 shows beams spaced 5 to 6 ft. on center with a 4 in. slab. Wood forms were used throughout and the ceiling finished by furring and plastering. Type 2 shows two large girders spaced 15 ft. 2 in. o. c., with a 2½ in. slab, 4½ in. by 6 in. joists spaced 16½ in. o. c. with clay tile filler, plaster applied directly on the soffit of tile and joists. Type 3 shows two large girders spaced 15 ft. 2 in. o. c. with a 2½ in. slab, 4½ in by 6 in. joists spaced 24½ in. o. c. with 16 in. gauge removable steel filler, and furring and plastering applied to the underside of the joists. Type 4 shows two large girders spaced 15 ft. 2 in. o. c. with a 4 in. slab and 8 in. by 6 in. beams spaced 7 ft. 6 in. o. c. Wood forms were used throughout and furring and plastering applied as in Type 3.

Fig. 6 shows a graphic chart of cost per class room based upon prices from reliable contractors. The advantages of Type 3 are low cost, perfect alignment of joists, accessibility for inspection, minimum weight and the fact that the plastering may be omitted. Type 1 is more expensive than indicated on the chart because of the extreme depth, making it necessary to use 14 ft. 7 in. floor heights.

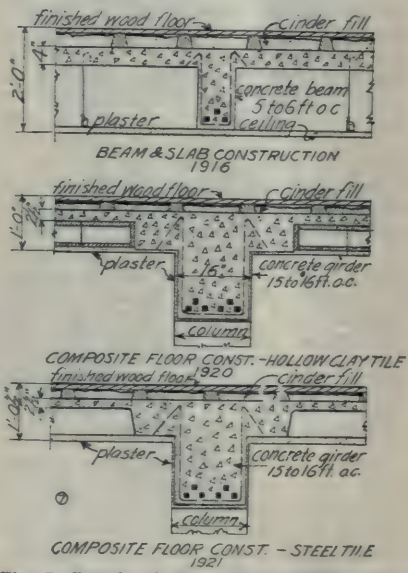


Fig. 7—Details of Three Types of Floor Construction Used in 1916, 1920 and 1921.

Fig. 7 shows a comparison of floor construction, giving details of three

different types as used in 1916, 1920 and 1921.

The information showing comparisons between wall bearing construction and column type was obtained from actual observation and investigation by the structural department under the direction of Irwin N. Cathacene, architect for the school district of Philadelphia.

Who Is Responsible for High Building Costs?

The Wide Misuse of the Percentage Statements of Dr. Gries of U. S. Division of Building and Housing Explained and Commented Upon in an Editorial in Contract Record and Engineering Review of Toronto, Can.

In recent discussions of building costs the statement or implication has appeared in many publications, that Dr. John M. Gries, chief of the Division of Building and Housing, of the U. S. Department of Commerce, "after a careful survey of building conditions" gives it as his opinion that labor charges account for so small a proportion of the construction cost of the average house, that increases in labor wages have little bearing on total building costs. The articles in question then point out that as, according to the "survey," labor was only 26 per cent of the cost of a house, a $5,000 house would only cost $650 less if there were a straight reduction of 50 per cent in the wages of labor employed on it. One newspaper states that this is an answer to charges circulated freely by those "higher up" in the building, that exorbitant wages entering into the cost of construction are responsible for the high prices that are making tenants instead of home owners out of people of moderate means.

Some of the publications dealing with this subject have even gone so far as to imply that while the labor cost of a $5,000 house represents only 26 per cent of the whole, the material cost amounts to 74 per cent. The general effect has been to convey the impression that the United States Department of Commerce sponsors the proposition that high building trade wages have little to do with the present cost of housing, and that the producers and purveyors of building materials are chiefly responsible for the situation.

It is interesting, therefore, as the National Lumber Manufacturers' Association points out, to ascertain exactly what Dr. Gries did say. It appears that a talk by Dr. Gries before officials of the Bureau of Standards was authentically reported in a Department release as follows:

"Figures were given showing the relative importance of the different items of construction costs for a certain house. Of these, labor charges accounted for only 26 per cent; materials cost 29.3 per cent; land, 19 per cent; contractor, 12.6 per cent; financing, 6.7 per cent; architect and real estate fees, 6.4 per cent. These figures show that it is not generally possible to blame one single factor, such as high labor or material costs, for high prices or houses. He said that while the daily wage of building tradesmen might seem high to a man employed all the year, they were not necessarily high when the seasonal character of the employment was considered. He said a substantial saving in labor costs could be realized if arrangements could be made for employment during a larger part of the year. He also said similar savings in costs of equipment and contractors' overhead could be effected by a more extended building season."

Dr. Gries' statement made it very plain that there are other factors in building costs besides those of labor and materials, which cannot rightfully be charged to either. In fact, the other factors in the case of the particular house he had in mind amounted to almost as much as the sum of materials and labor. In view of that situation he was merely rationally pointing out that little relief from the high cost of building could be expected from reductions in any one factor—the thought being that relief, if any, must come from an all-round reduction of building costs. The validity of this view is illustrated by the recent experience in many cities of a reduction in the cost of materials being quickly absorbed by an increase in the cost of labor.

Dr. Gries remarks that exaggerations by contractors and material men on the one side and labor on the other, of the costs chargeable on the other side in building, are harmful to both.

Rock Drills for Structural Work

Speed and Economy Through the Use of Tools of This Class Described in Dec. 5 Issue of Contract Record and Engineering Review, Toronto, Canada

By F. A. McLEAN

On bridge or structural work, in the installation of conduit, piping, motors, generators, machine tools, fire escapes, crane runways, shafting, steel door frames, window sashes, buffer plates, cornices, balconies, etc., it is often necessary to drill holes of various diameters and depths in stone, brick or concrete.

The usual method of drilling these holes with a pipe bit or a hand steel and hammer is by no means satisfactory for several reasons. Cutting speeds seldom exceed 1 ft. per hour and the work is both costly and tiresome. It is almost impossible to strike the steel with a uniform blow and the holes are often larger than actually needed or are of irregular shape and need a lot of patching up with cement or mortar. This makes an unsightly job and sometimes an unsafe one as well.

When there are a large number of holes to be drilled or where work is held up, pending the drilling of anchor bolt holes, the cutting or trimming of rock for a foundation or the installation of wiring or pipes, the cost of drilling the holes by hand may be far greater than the cost of the power drilling equipment necessary to do the work.

Holes Drilled in One-fifth of the Time.—Rock drills of various standard types have been successfully used by contractors on the heavier forms of this work for several years. A notable example of their value in this respect occurred during the rebuilding of the Thomas A. Edison plant at East Orange, N. J. On this job it was found necessary to drill 9,500 holes in the concrete walls to take expansion bolts used for holding the steel window frames in place. Each hole was ¾ in. in diameter by 3½ in. deep. Through the use of a "Jackhamer" with a special extension steel the work was accomplished in about one-fifth of the time that it would have taken by the hand method. Two men handled the drill, one holding the drill itself and the other guiding the bit. They averaged 500 holes a day, their work including the frequent moving of the scaffolding and the changing of air connections.

This is a good example of a large number of small anchor bolts drilled economically. An example of a large number of large anchor bolt holes bored at low cost is found in the construction of the Quebec Bridge. On this job there were 176 holes 4¾ in. in diameter and 5 ft. deep to be drilled through hard granite. The work was done by a "Calyx" chilled-shot core drill such as is regularly employed for testing pavement and exporing mines. On some occasions drills of this type have been known to cut without trouble through reinforcing rods and heavy steel L-beams embedded in masonry.

One of the earliest known applications of rock drills for breaking masonry was for cutting out concrete and brickwork at the New York end of the Brooklyn bridge to make room for a subway terminal. Hand hammer drills of the one-rotating type were used, as neither the more suitable automatically rotated rills or the modern paying breaker had been developed at that time. The work necessitated cutting through, first, an 18 in. layer of fine cement concrete; next, about 3 ft. of rough gravel concrete; and finally, the brick supporting arches or vaulting. The material was cut away in layers or benches, first, the top layer, which though hard, was fairly uniform and good cutting; next, the rough concrete, which was very difficult to cut; and then the brick, which was comparatively easy to cut. In one instance it was found necessary to cut through a steel tie. This was accomplished with the same drill as was used for the concrete in the surprisingly short time of 12 minutes. Blasting was prohibited in this confined place—very close to one of the most congested of traffic arteries, and these drills were called upon to pick out all the material piece by piece. For this work a solid hexagon steel with narrow-pointed chisel about ¾

in. across the cutting edge was employed.

A tunnel was constructed in Seattle several years ago to connect the King County courthouse with the city hall. This work necessitated the removal of large concrete foundations, for which purpose a Jackhamer was employed. The drill was observed to work at as fast a rate as 1 ft. per minute.

Large concrete foundations were removed by this method at Brighton (England) Corporation Electric Works. The concrete was exceptionally hard and many of the broken blocks weighed as much as 20 tons each. An ordinary chisel bit 20 in. in length was employed for drilling holes all around the foundation, about 9 in. apart and 18 in. deep. The average speed of drilling was seven holes per hour, that is, about 10 ft. of hole per hour.

Useful When Installing Equipment.—A small rock drill has seen considerable service at a large printing plant. The floor construction is of concrete with brick arches, and the ceiling of tile. The space between the floor and ceiling is used for piping, electric wires, etc., and it is often necessary to cut holes in the floor or ceiling when installing machinery or lights. The drill takes its air from the regular 50 lb. air lines in the building. When cutting concrete flooring, one man can drill a hole through the floor (10 to 10½ in. thick) in 2½ minutes. Ladders or staging are required for ceiling work, and for such work two men handle the drill.

In another case where hanger holes were drilled in rock, it formerly required a whole day for two men with hammer and steel to drill 9 or 10 holes, each 4 to 6 in. in depth, whereas now one man drills the same number of holes in 10 to 15 minutes with a hand hammer drill.

Hundreds of elevated railway column foundations were removed in New York with the aid of Jackhamers. These brick footings were located above the new subway in the lower part of the city and have been replaced by concrete foundations. These footings were in the shape of tuncated pyramids eight or more feet high and about 4 ft. square on top. After the elevated structure had been supported on falsework, holes were drilled from 12 to 20 in. in depth. The brick was then broken out with sledge-and-wedge. The same type of drills are often found useful in bridge work for drilling or enlarging anchor bolt holes, trimming off piers, attaching girders to masonry supports at the shore ends, etc.

With the exception of such jobs as cutting large hard rocks for foundations, rock excavation, boring frozen ground or tearing out old concrete or masonry foundations, structural rock drilling requirements can often be met by a somewhat smaller and less powerful drill than the regular jackhamers. With this idea in mind, one company, the Canadian Ingersoll-Rand Company, has developed a very light hammer drill known as the "Industrial Jackhamer."

Light Drill for General Work.—The industrial jackhamer is designed for the use of contractors and general work around industrial plants, weighs 21½ lb., uses ⅞ in. hollow hexagon steel with bits of up to 1⅝ in. in diameter, consumes 30 to 35 cu. ft. of air per minute at pressure of 60 to 100 lb. and is adapted to all forms of drilling where the rock is not excessively hard and the depth of the holes required not over 5 ft. Its light weight and small over-all dimensions relieve the operator from unnecessary fatigue and enable him to drill a far larger number of holes in a given time than can be done by the best hand drilled. It is also easily operated in places that could not be reached by hand or with a heavier tool.

In general design the industrial jackhammer resembles the larger jackhamers, the valve mechanism and other parts being similar. All ports are short and direct the inlet, being separate and distinct from the exhaust. The rotation is simple, sturdy, automatic and positive. A rifle bar and ratchet are located in the back of the cylinder and impart a rotary motion to the piston, which in turn rotates the chuck holding the drill steel, on much the same principle as that made use of in the ordinary automatic screwdriver.

Plug Drilling Attachment.—Where there is only an occasional need for drilling a limited number of small holes in stone, concrete or brick a plug drilling attachment will be found useful. When applied to a chipper a simple plug drill is formed that will drill ¼ in. to ¾ in. holes to a depth of 6 or 8 in. at a rate of speed that far eclipses hand work. When the

required number of holes have been drilled, the tool is quickly converted into a chipper again, ready to do the work usually done by these tools. In addition it may be used for toothing out bricks, enlarging drilled holes, dressing up concrete and stone, etc.

The plug drilling attachment consists of an alloy steel bolt constructed so that a portion of the air from the exhaust of the tool is deflected and carried through a short hose to a special blowing attachment, which clears the cuttings from the hole. A rotating wrench, hose connections and a diamond point or rose bit completes the outfit. The tool is held in one hand and a semi-rotary motion is imparted to the wrench as the drilling proceeds.

It is perhaps needless to point out that while the largest size of bits that are recommended for use with the industrial jackhammer and the chipping plug drill are respectively 1⅝ in. and ¾ in., neither tool is limited to production of holes of these diameters or under, since a number of holes can be drilled very close together and the intervening webs then broken out by a few sharp blows from a hammer, by chiseling or wedging, or by holding the tool against them and turning on the air, allowing the vibration to break them loose. Large holes drilled or cut in this way are generally more regular in shape than those cut by hand. This class of work is usually encountered where it is necessary to cut openings for belts, shafting, windows, etc.

When holes are drilled dry in concrete with hand rotated tools, the natural moisture present seems to cause the cuttings to pack and form a mud collar back of the bit, making it necessary to withdraw the steel with a Stillson wrench, causing considerable delay. This trouble does not occur with the automatically rotated type of drill because the air jet keeps the hole clean so that the steel can be easily withdrawn by means of the steel holder, which is an integral part of the drills. The automatically rotated drill is also valuable when elbow room is restricted or footing insecure, as on ladders, false work or swinging scaffolds.

The drills previously mentioned will answer for practically all classes of rock drilling around the average structural job. Where a number of deep or fairly large overhead holes are required, however, it is sometimes more economical to use the "Stope-hamer" type of drill employed for overhead drilling in mine raises and stopes. These drills are equipped with an air operated feed cylinder which forces the drill forward, thus relieving the operator from the weight. Drills of this type are used either wet or dry, cut rapidly and are very easily controlled even in very close quarters.

This article does not by any means cover all of the possible applications of rock drills or structural work. The writer hopes, however, that some of the "kinks" will prove useful to those engaged in construction work.

Building Construction in November

The country's building activities continued their lead over last year through November, according to F. W. Dodge Corporation. Total contracts awarded during the month in the 36 Eastern States (including about seven-eighths of the country's total construction volume) amounted to $318,828,000. Although this was a 12 per cent drop from the October figure, in 27 of these states (for which records were kept last year), there was an increase of 19 per cent over last November. As in October, the heaviest increase in construction activity was in New York State and Northern New Jersey, which was the only district showing an increase over October.

Included in November's record were the following important items: $158,953,000 or 50 per cent, for residential buildings; $44,457,000 or 14 per cent, for industrial buildings; $36,237,000, or 11 per cent, for public works and utilities; $32,594,000, or 10 per cent, for business buildings; and $24,273,000, or 8 per cent, for educational buildings.

Total construction started in the 36 Eastern States during the first eleven months of this year has amounted to $3,237,068,000. In 27 of these states the lead over the corresponding period of last year is a little more than 3 per cent.

Contemplated new work reported during the month amounted to $623,704,000, an increase of 10 per cent over the amounted reported in October.

Cost of Paint Versus Cost of Painting

Economies and Other Advantages of the Modern Air Brush Described in an Article Condensed from Compressed Air Magazine

By HOWARD W. BEACH,
Eclipse Air Brush Company, Newark, N. J.

How many manufacturers realize that the cost of paint represents less than one-third the cost of painting when the paint is applied by hand-brush workers? Records made of a typical case of painting a plant by the hand-brush method reveal that $4,200 was spent for labor to apply paint costing $1,800, or $2 for labor for every dollar paid for paint. This is a fair case. In ordinary factory maintenance, $4, $5 or $6 are not infrequently expended for labor to apply a dollar's worth of paint.

One way to save is to use good paint. The better the paint the longer the interval between painting—hence a lower outlay per year of service. On the other hand, supposing paint to cost nothing at all, the labor charge to brush the paint on by hand would still loom large on the books.

A similar but much larger plant than the one referred to in the beginning of the article was painted recently by air brush. The costs were: $4,000 for paint and $1,800 for labor. Compared with the first example, air-brush application here saved over 50 per cent of the cost of painting. Labor saving, great as it is, however, is not the only advantage of air-brush painting. Speed, cost of scaffolding, accident prevention, ability to reach surfaces inaccessible to the hand brush, are other important features. For instance, it is sometimes just as necessary to make speed as it is to save money. Air-brush aplication, as has been emphasized, takes but a fraction of the time required to do the same amount of work by hand brush. Recently the exterior of a good-sized plant was both cleaned and painted by air in 100 man-days as against the 500 days estimated for hand-brush work. The low-pressure air brush applies paint at hand-brush consistency without special thinning, hence a dense and elastic coat is obtained. More paint may be put on at one application by air than by hand. On inside work, one coat applied by air can, therefore, be made to equal a two-coat, hand-brushed job, while on outside work two air-brushed coats equal three hand-brushed ones. These factors are important in reckoning both cost and speed of painting.

Brightening Up the Interior of a Shop With a Coat of Mill White Applied by Means of a Portable Air-Brush Outfit.

Obviously, "over-the-week-end" painting is desired in most factories. It is clear from the foregoing that the air brush is an adept Saturday to Monday worker.

Materials, parts, and finished products must not be damaged by spattering paint. Where paint is dipped out of a can by brush, drop cloths must be rigged up for protection. With the air

brush the operator's entire attention is given to the application of the paint. He does not have to bend, fill his brush, and swing it over his head. The spray of paint, issuing from a low-pressure air brush, is under his complete control; and all the paint goes on the surface to be covered. Drippings and objectionable fumes are eliminated. Strange as it may seem to those that have done home painting jobs, and that have wondered at the amount of paint that was spattered on clothes and on floors, entire plant interiors have been painted by air brush without drop-cloth protection and without the slightest damage to materials lying directly beneath the painted surfaces.

COMPARATIVE COST FIGURES ON LARGE WORK

Cost Per 100 Sq. Ft. Ceiling—Air Brush

Labor	$1.05
Material	1.00
Power	.03
Depreciation	.005
	$2.085

Cost Per 100 Sq. Ft. Ceiling—Hand Brush

Labor	$2.62
Material	1.10
	$3.72

Painting Wall, No Scaffold, 100 Sq. Ft.—Air Brush

Labor	$0.30
Material	1.00
Power	.03
Depreciation	.005
	$1.335

Painting Wall, No Scaffold, 100 Sq. Ft.—Hand Brush

Labor	$1.20
Material	1.10
	$2.30

Scaffolding is another item in the cost of painting. The air brush, because of its wider range, materially reduces the amount of work that must be done from scaffolding and even from ladders. Where ladders or scaffolding are necessary, the air brush diminishes the hazard of falling. The operator has only the "gun" to handle and is not bothered with the open paint pot or the constant dipping of the brush. The physical effort is less with the gun than with a bristle brush, as the operator does not have to wipe out or spread the paint. One large works, in figuring estimates for painting, allowed $10,000 for probable claims arising from scaffold falls, based on past experience with hand-brush workers. The job, however, was done by air brush without a single accident of that kind.

The saving in dollars and cents effected with the air brush has been indicated by the facts presented. But there is still another side to the question. Plants which own an air-brush equipment seem automatically to "spruce up."

The paint-maker's famous slogan, "Save the surface and you save all," is a good one, but it tells only half the story. Preservation is one thing, but, nowadays, owners and manufacturers do not paint for preservation alone. Plants are kept freshly and brightly painted for the effect on the morale of the employees. Paint is used to create better lighting and thus to increase production and to decrease spoilage. Actual production increases of 10 and 12 per cent are common after a factory interior has been painted with a proper regard to lighting values. White paint reduces electric light bills, in fact, 25 per cent of the lighting cost has been saved in this way at the Staten Island ferry terminals of New York City.

Paint is also used for its sanitary value. One paint manufacturer has demonstrated that it pays to paint white spots in the corners of floors. Workmen won't spit on white paint. In short, there are a hundred and one important uses for paint in industry.

An air brush may be bought originally to lessen the difference between the cost of paint and the cost of painting; but, once utilized, the air brush soon becomes a regularly employed maintenance tool that makes any plant a better place to be in physically, mentally, and morally.

Another use of the air brush or paint-spraying machine is in the economical application of metal protective coatings. Asphalt and graphite paints, iron oxides, and 20 and 25-pound red lead can all be applied at hand-brushing consistency and, latterly, it has also been feasible to spread an oil preparation or rust-proofing compound in the same manner. The fatigue that is felt by the painter when applying red lead in the old way is eliminated by the air brush, and it also enables the operator to put on a more even coat and to better protect seams, rivet heads, etc., because of the penetrating force given the paint by the air impulse.

The use of compressed air for painting is not confined to heavy,

rough work. At the present time, automobiles are being finished at the factory from undercoaters on through to color varnishes; and even the finishing varnish is being applied by air.

Furniture of every description, from the cheaper grades on through to the very finest, are finished by the air-brush method. Shellacs and varnishes, stains, enamels, etc., are all applied by means of compressed air; and the results are better than those obtained by the use of the hand brush.

The principle involved in applying paints, enamels, japans, lacquers, etc., by the aid of compressed air is also being utilized to spray silicate of soda, paraffin, waterproofing oils, etc.

Notable Stage Elevator Installation

Accomplishment at Grauman Metropolitan Theater in Los Angeles Described in The Architect and Engineer

Forty years ago the first power freight elevator in Southern California was built by the Baker Iron Works of Los Angeles for H. Newmark & Co., wholesale grocers of that city.

A few weeks ago this same firm built what is said to be the largest and most powerful electrically-operated platform in Southern California. The first job undertaken by this pioneer company resulted in what today would be considered a crude and miniature elevator, while the second instance resulted in the immense orchestral elevator and pipe organ console lift in the new Grauman Metropolitan Theater.

This immense platform, 55 ft. in length and 15 ft. in width, is capable of lifting an orchestra of 100 musicians with their music racks and instruments. The organ console lift, working independently of the orchestra lift, is five feet ten inches wide and nine feet seven inches long.

The main lift may be operated either by the director from his stand or by the stage manager from one of the wings of the stage. The console platform is operated by the organist. Both platforms are noiseless in operation, and may be stopped at different stages of elevation through the pressure of different buttons. There is no creeping in either of the platforms, as each stops flush with each floor objective and remains there indefinitely without shifting. This phase of the construction was necessary, as the orchestra platform is often used as an additional unit to the main stage when dancing acts are used and where absolute floor smoothness to eliminate tripping hazards is called for.

Two 25-h. p. General Electric motors operating four screws—the screw method rather than cables or hydraulic plungers were used—operate the large platform, while a 10-h. p. motor furnishes motivation for the console platform. Only one screw is used for this lift.

The screw method was decided upon because of the insurance against slipping as well as the fact that all chances of a drop in case of accident are eliminated. The four screws used in the large platform are geared together in such a manner that possibilities of slipping, tilting or sticking at the ends are likewise eliminated.

The machinery is housed in a soundproof room beneath the pit of the orchestra platform, while additional noise-proof assurances are obtained through the employment of numerous rubber-tired guard wheels fixed to the sides of the platforms.

Although the theater is famous for its wonderful interior decoration and lighting effect, the effect produced by these two moving platforms is a matter of considerable comment from the audience. They have been in operation for several weeks and are reported to have fulfilled all of the expectations of the owners.

Apprenticeship in Construction Industry.—A national program on apprenticeship for the construction industry was launched Dec. 5 by the apprenticeship committee of the American Construction Council at the first meeting of the committee, held at Buffalo. This committee is composed of representatives of all elements of the construction industry throughout the entire country, including employers, manufacturers and professional bodies, as well as the various trades and crafts representing labor in the industry.

Architects' Findings and Recommendations Following the Japanese Earthquake of Sept. 1, 1923

Report of W. M. Vories & Co., Architects of Kajima Bank and Daido Insurance Buildings, Osaka

By DANIEL O. LARSEN
Architect in Charge of Design and Construction

Inspection was made of about thirty modern buildings in Tokyo and Yokohama, including some that were totally destroyed by the earthquake, some that were destroyed by fire only, some that were more or less damaged by the earthquake, and some whose interiors were burned out but whose structure is sound, also several buildings that were not damaged at all by earthquake or fire.

Fireproofing.—Not a single building in either Tokyo or Yokohama was thoroughly fireproof, wood and combustible material being used more or less in the interiors of all buildings. Even the buildings remaining undamaged by earthquake or fire would not have survived, had the fire swept that area.

Elevator Shafts.—Most buildings had open elevator shafts and open staircases from first floor to roof, making a wonderful flue for the fire to spread throughout the whole building.

Wire Glass vs. Steel Shutters.—Wire glass stood the test much better than steel shutters. In many places the earthquake threw the steel shutters out of line, causing them to stick and making it impossible to shut them before the fire came. Even where the shutters were lowered, the heat buckled the steel and allowed the flames to come through. This was especially true in the Mitsukoshi Department Store. Most of the buildings of recent date had steel shutters in at least some parts of the building, but in comparatively few were they even lowered.

Wire glass would have saved the Yokohama City Y. M. C. A., which was in the heart of the hottest fire, if it had been used on the front as well as on the three sides. After the fire had burned itself out on three sides, the building on the inside was in perfect condition, and not until several hours later, when the flames swept in from the front, where sheet glass was used, was any damage caused. Even now the wire glass throughout the building is intact, and the third floor is practically unharmed except for smoke.

A similar illustration is that of the National Y. M. C. A. Building in Tokyo, where practically all the wire glass is intact.

Foundations.—The continuous slab reinforced concrete foundations stood the effects of the earthquake in most every case, whereas buildings with individual spread footings went to pieces. This was well illustrated in such buildings as the Kogyo Bank Buildings, the Imperial Hotel, Mitsubishi Building No. 27, several of the Marunouchi Buildings, and many others which show practically no damage.

Of course other factors enter into the stability of these buildings, but the foundations are the most important.

Curtain Walls.—Reinforced concrete or solid brick curtain walls are necessary up to at least the sixth floor. We found no buildings even with hollow tile curtain walls having any damage above this point. The Kogyo Bank which shows no damage, has a reinforced concrete wall up to the third floor and all corners have reinforced concrete curtain walls; all other walls are solid brick.

The Okawa and Tanaka Building which shows no damage, have solid brick curtain walls.

Inside Partitions.—It was found that most of the buildings which stood the earthquake the best, had several solid partitions running through the building. These partitions were either of reinforced concrete or brick.

It was further discovered in the buildings that stood the test, that the upper floors had very light partitions and very light curtain walls.

The ceiling heights of each story should be as low as possible.

Floor Construction.—Concrete floor tile construction stood the fire test much better than the solid concrete slabs. This was well illustrated in

comparing the Kajima Bank (Tokyo branch) with the National Y. M. C. A. neither of which was damaged by the earthquake, but which were completely burned out by the fire. Both buildings had wood partitions, wood doors and trim, and the office equipment more or less the same. In the Kajima Bank the concrete in the solid slab was seriously damaged by the fire on both the first and second floors, and some places on the third floor, and large sections of this will have to be reconstructed; whereas in the National Y. M. C. A. building the floor tile on every floor is in perfect condition. Another good example of this is the Yokohama Y. M. C. A. The only reason for this is the air space between the floor tile, which makes a perfect insulation against the heat.

Columns.—The steel columns encased in brick or hollow tile did not stand up. This was well illustrated in the N. Y. K. Building, the Tokyo Kaikan, and the Urakukwan building. In these buildings the brick work and hollow tile completely broke away from the steel and in some places the steel was seriously damaged.

Steel columns encased in concrete stood up very well, as was illustrated in the Kogyo Bank and the First Mutual Life Insurance Co. Building. The latter building was partly burned out but structurally it is in very good shape.

Reinforced concrete columns stood up well where the concrete was well mixed, and the ingredients were clean. This was illustrated in the Mitsubishi building No. 27, the National Y. M. C. A. Gymnasium. In the last mentioned building there were five reinforced concrete trusses supported on columns 26 ft. high, and although this building was completely burned out, no damage was caused to the structure by earthquake or fire. These trusses had a span of over 60 ft.

Exterior Finish.—It was very noticeable that the exterior finish cracked in proportion to the strength of the structure. Two buildings, for example, the Nippon Sekan and the Kogyo Bank, both of which had granite finish on the first three floors and imported terra cotta on the upper floors, were affected differently by the earthquake. The first building, which had steel columns encased with brick and hollow tile, was seriously damaged by having both the stone and terra cotta crack very badly throughout the building. The Kogyo Bank, which had steel columns encased in concrete, and perhaps had a better foundation does not show any crack in either stone or terra cotta.

In the various buildings that were burned, the stone whether granite, marble, or lime stone, was badly cracked and chipped by the heat. On the other hand where hard burnt tile or terra cotta was used, very little damage was done.

Roofs.—Where asphalt roofing was used and was not protected by cement or tile, the roofing was seriously damaged. This was illustrated on the Kajima Bank where the asphalt and gravel roof was exposed, and the heat caused much damage. On the other hand the Yokohama Y. M. C. A. and the National Y. M. C. A. in Tokyo, where the asphalt was protected by cement, the roof was found to be in perfect condition. All three of these buildings were subjected to equally severe heat.

Apparatus for the Study of the Corrodibility of Metals

Work which has been under way at the U. S. Bureau of Standards for some time on the corrodibility of metals has been previously referred to in the bulletin. In the study of this property of metals, two general methods are available. The metal may be subjected to a combination of conditions which simulate the actual service to which it is to be subjected, or the metal may be subjected singly to the various influences, which combined, constitute the service environment. There is now available at the bureau apparatus for a series of different tests as follows: (a) simple immersion within a corrosive medium, the temperature of which is accurately controlled; (b) repeated immersion in a corrosive medium followed by withdrawal into the atmosphere; (c) a modification of (b) which permits holding the specimen in the air for a period as long as one hour, if desired, which will allow thorough drying of the surface before it is reimmersed; and (d) exposure to a fine mist of the corrosive medium. Apparatus now being developed will permit the specimen to be subjected to a series of conditions successively, the whole cycle being comparable to the actual atmospheric conditions which the material has to withstand.

Monthly Statistics of the Building Industry

The accompanying tabulations are taken from the Survey of Current Business, a publication of the U. S. Department of Commerce. They show (1) the building contracts awarded by thousands of square feet, and thousands of dollars, (2) the index numbers for building contracts awarded, (3) the building material price index for frame and brick houses, (4) the cost index for constructing factory buildings, and (5) the index numbers of wholesale prices for structural steel, iron and steel, composite steel and composite finished steel.

The figures on building contracts are based on data compiled by the F. W. Dodge Co., covering small towns and rural districts as well as large cities in 27 northeastern states. Prior to May, 1921, the building figures covered 25 northeastern states and the District of Columbia. The states are those north and east of, and including, North Dakota, South Dakota, Iowa, Missouri, Tennessee, and Virginia, together with portions of

	Grand Total Building Contracts		Index Numbers		Building Material Price Indexes		Cost Index	Wholesale Prices Index Numbers			
Year and Month	Thousands of sq. ft.	Thousands of dollars	Sq. ft.	Value	Frame house	Brick house	Factory building costs	Structural steel beams (Pittsburgh)	Iron and steel	Composite steel	Composite finished steel
1913 monthly av.	.....	$71,475	.....	83	100	100	.....	100	100	100	100
1914 monthly av.	.....	60,020	.....	28	.....	.....	100	83	87	88	86
1915 monthly av.	.....	78,841	.....	36	.....	.....	.....	93	94	95	92
1916 monthly av.	.....	115,082	.....	53	.....	.....	.....	177	154	163	161
1917 monthly av.	.....	134,086	.....	63	.....	.....	.....	269	256	259	252
1918 monthly av.	.....	140,770	.....	65	.....	.....	.....	202	215	220	213
1919 monthly av.	46,683	214,990	100	100	.....	.....	.....	174	191	193	188
1920 monthly av.	33,491	211,102	72	98	.....	.....	.....	187	249	211	222
1921 monthly av.	32,267	196,643	69	91	.....	.....	179	131	155	156	152
1922 monthly av.	47,745	279,410	102	130	182	186	170	115	144	134	134
1921											
January	15,513	111,608	33	52	.....	.....	.....	.....	.....	.....	.....
February	16,807	100,677	36	47	.....	.....	.....	.....	.....	.....	.....
March	26,709	164,092	57	76	.....	.....	.....	.....	.....	.....	.....
April	34,494	220,886	74	103	.....	.....	.....	.....	.....	.....	.....
May	35,751	242,094	77	113	.....	.....	176	146	165	170	166
June	35,738	227,711	77	106	.....	.....	172	146	159	165	159
July	31,717	212,491	68	99	.....	.....	167	139	145	153	148
August	35,246	220,721	76	103	.....	.....	161	123	137	144	141
September	41,702	246,186	89	115	.....	.....	155	123	134	138	136
October	40,436	222,480	87	103	.....	.....	157	116	135	134	134
November	37,818	192,311	81	89	166	173	154	106	132	133	128
December	35,272	198,518	76	92	173	179	153	99	129	130	127
1922											
January	30,261	166,320	65	77	174	179	152	99	127	126	124
February	30,061	177,473	64	83	169	174	152	99	126	124	121
March	51,957	293,637	111	137	169	173	152	96	125	122	122
April	58,146	353,162	125	164	168	172	152	99	131	126	125
May	59,639	362,590	128	169	173	176	157	108	139	127	127
June	60,526	343,440	130	160	178	181	165	106	140	129	130
July	51,705	350,081	111	163	181	184	171	109	142	130	131
August	54,019	322,007	116	150	189	193	174	116	151	137	138
September	44,275	271,493	95	126	193	197	190	137	156	145	146
October	46,806	253,137	100	118	196	199	192	141	156	149	148
November	46,946	244,366	101	114	196	201	192	136	160	149	146
December	38,608	215,213	83	100	192	198	192	132	154	149	147
1923											
January	38,947	217,323	83	101	195	199	192	132	156	151	149
February	41,611	229,938	89	107	198	201	197	139	162	158	157
March	64,920	333,518	139	155	203	205	197	146	171	165	164
April	64,527	357,475	138	166	206	209	204	172	179	174	169
May	60,430	374,400	129	174	212	214	208	174	180	176	168
June	46,344	323,559	99	150	212	215	206	169	177	176	168
July	42,021	274,224	90	128	214	217	206	166	172	176	167
August	39,786	253,106	85	118	208	210	206	166	170	176	167
September	38,968	253,525	83	116	203	207	204	166	170	176	167

eastern Kansas and Nebraska. Beginning May, 1921, North Carolina and South Carolina were added to the list, but this addition is stated to have little effect upon the total.

The price indexes for frame and brick houses are from the U. S. Department of Commerce, Bureau of Standards, Division of Building and Housing and Bureau of Census, and are based on prices paid for material by contractors in some 60 cities of the United States. The prices are weighted by the relative importance of each commodity in the construction of a 6-room house.

The index number for constructing factory buildings is furnished by Aberthaw Construction Co., and is designed to show the relative changes in the cost of constructing a standard concrete factory building. The company believes that the year 1914 gives a normal base and that July, 1920, with an index number of 265, represented the peak of costs.

The index numbers of wholesale prices for structural steel, etc., are obtained as follows: The prices for structural steel beams are the average of weekly prices from the U. S. Department of Labor, Bureau of Labor Statistics. The figures for iron and steel are the average of weekly prices compiled by the Iron Trade Review on the following 14 products: Pig iron, billets, slabs, sheet bars, wire rods, steel bars, plates, structural shapes, black galvanized and blue annealed sheets, tin plates, wire nails, and black pipe. Pig iron average in turn is average of 13 different quotations.

The figures for composite steel are compiled by the American Metal Market and represent the average price per pound of steel products weighted as follows: 2½ lb. bars, 1½ lb. plates, 1½ lb. shapes, 1½ lb. pipe, 1½ lb. wire nails, 1 lb. galvanized sheets, and ½ lb. tin plate.

The composite price of finished steel products is compiled by the Iron Age. It includes: Steel bars, beams, tank plates, plain wire, open-hearth rails, black pipe, and black sheets. These products, according to the Iron Age, constitute 88 per cent of the United States output of finished steel.

Structural Conditions Leading to the Spread of a Fire from an Old Three-Story Hotel to the Fifth and Seventh Floors of a Class A Building

Slightly Condensed from a Report to the National Board of Fire Underwriters

At the request of several of our members, Assistant Chief Engineer Robt. E. Andrews visited Stockton, Cal., July 30, 1923, to report on the fire of the preceding day, which involved a quarter block at the northwest corner of Main and Sutter Streets. Nine ground floor mercantile establishments, with a 100-room hotel occupying two floors above them were entirely destroyed and an adjoining Class A building was severely damaged. The total loss is roughly estimated at $700,000.

Danger Long Recognized. — The block in which the fire occurred was described in detail in the report on the city issued by the National Board of Fire Underwriters in August, 1921. It is characterized as being one in which the conflagration hazard is especially marked and attention is drawn to the poor accessibility and the large size and numerous structural weaknesses of the buildings. The statement is made that "fires too large for the fire department to control could easily occur in this block."

Many Natural Flues.—The stores and hotel above them formed one fire area of about 18,000 sq. ft., which was L-shaped and surrounded the bank and office building on two sides. Five of the stores faced Main Street; the others and the ground floor lobby of the hotel faced Sutter Street. The building was of joisted brick construction three stories in height with brick walls one story high separating the stores. In places walls extending through the second and third stories were carried on steel beams on steel or cast iron columns. All metal was unprotected. Walls were mostly 12 in., although some 8 in. walls were noted; parapets were low and 8 in. thick.

The hotel is said to have been built about 40 years ago and has repeatedly been remodeled, added to and combined with adjoining buildings. Recently it has been used for lodgings

only. Ceilings were originally very high and when modern plumbing was installed, false ceilings were built leaving about a 2 ft. space for pipes. There were three frame tin-clad and one brick light wells extending through the second and third stories, all with unprotected openings; also five skylights, either of wire or glass or of plain glass, protected with wire netting. The one elevator shaft was enclosed with wood and plaster partition and stairs were open. Heating apparatus was installed in a small one-story addition having brick walls and concrete roof.

Conditions in the Modern Building.—The bank and office building built in 1915 covers about 3,500 sq. ft., and is 10 stories in height. It is of steel frame construction with 12 in. brick curtain walls and reinforced concrete floors. The elevator shaft is enclosed, but the stairway is unprotected. Window openings above the hotel are protected with wire glass in metal frames bearing the label of the Underwriters' Laboratories. Windows on the street fronts are unprotected. The building has a standpipe and hose system with water from a pump driven by electric power from a public service corporation.

Fire Traveled in Concealed Spaces.—A police patrolman discovered the fire apparently near the rear of the hotel lobby at 3:25 a. m. The fire was difficult to locate. The ladder company, assisted by police and hotel employes, was busy in rescuing hotel guests, while engine companies at once began to fight the fire. Eight lines of hose were laid from the two engines, most of which had 1⅛ in. nozzles. After a few minutes it was believed the fire was under control, but it traveled in the concealed pipe spaces and broke out in the hotel lobby, and somewhat later near the Main Street front.

Inside Wooden Trim Ignites by Radiation.—The heat generated by the fire was intense, and although there was no wind, its full force was directed against the adjoining bank and office building rising seven stories above it. About 6 a. m. fire gained entrance to the fifth and seventh floors, mainly through the radiating heat igniting the wooden trim, curtains and other combustible material near the windows. There is a rumor that one window was lowered a few inches from the top after all had been closed by a bank official. Melting of the wire glass at a temperature higher than that for which it was intended may have allowed the fire to enter directly in some cases. Due to the shutting off of electric power, the fire pump protecting the building was of no assistance. The fifth and seventh stories were completely gutted with less damage to the sixth. Stories above were damaged by smoke and those below by water. Considerable damage was done to ornamental terra cotta work.

The fire was stopped on the west by a brick fire wall, and was prevented from crossing a narrow alley to the north, exposed windows being protected by tin-clad shutters. The water supply was ample.

The Outstanding Lesson.—The outstanding lesson of the fire is the hopelessness of extinguishing a fire once well started in an area of this size, which is exactly three times that permitted by the building code, recommended by the National Board of Fire Underwriters. Had areas been properly limited by the construction of substantial fire walls with all openings protected by standard fire doors, there is no doubt that the fire would have been confined to one section and the ensuing loss would have been correspondingly reduced.

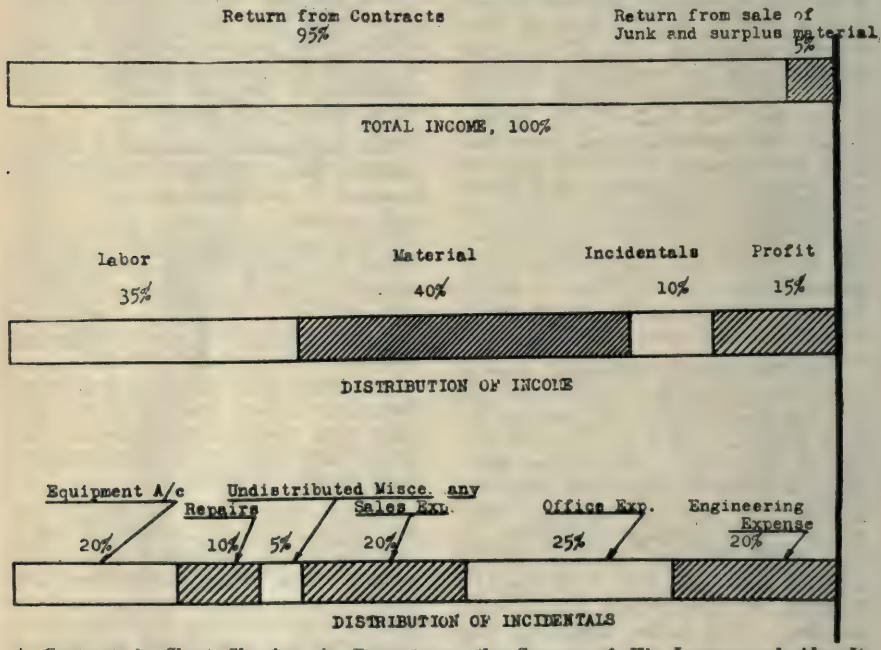
Furthermore, the fire would not have gained entrance to the bank and office building. Standard wire glass windows with metal frames form adequate protection against moderate exposure, but a building like the one in which the fire originated, which was of excessive area, ordinary construction and honeycombed with vertical and horizontal flues, cannot be considered less than severe. The limit of resistance of a wired glass window is reached at about 1,600° F., when the glass will melt and drop from the sash. On this account our building code "strongly recommends that all window openings exposed to buildings within 15 ft,, where considerable fire hazard exists, shall be protected by approved shutters or outside open sprinklers in addition to the fire windows."

What the Contractor's Banker Should Know

An Effective Method of Presenting This Information Described in a Paper in "The Permanent Builder" for November

By JAMES F. ADAMS
Industrial Engineer

Calling on the banker in search of a loan is no very pleasant occupation. Possibly your banker is like the one who promised a loan if the customer could tell which of the banker's eyes were artificial. And then had to give it for the reason that the customer chose the proper one, giving as his reason: "It looked the more sympathetic when I asked for the loan."



A Contractor's Chart Showing, in Percentages, the Sources of His Income and Also Its Distribution, Which Will Give the Banker a Sound Idea as to the Contractor's Business Ability.

Whatever sort he is, the banker is the guardian of the interest of his depositors, and to properly do so must exert the greatest of business judgment in the choice of his loan risks. He is just as anxious to have the funds of the bank at work as is the borrower to receive them; but he needs to know that there is every chance that they will be returned safely at the end of the borrowing period.

A Successful Presentation.—A certain manufacturer friend of mine called upon his banker, urging a seasonal loan for the furthering of his business. To support his plea there was submitted a chart which he had worked out in his own offices for personal use, but which he felt would also interest the man who was to make a temporary investment in the manufacturer's business. It was so well received that the banker asked for a copy to present before his board of directors that they might also benefit therefrom.

Like most of the other charts which have found their way into the business world, this is a very simple one to read or prepare. In it is every element which is of interest to the banker in the making of a loan. In a continued preparation of them from year to year is the gathering of a summary of the season's business

that cannot be replaced for many a dollar.

Construction of the Chart.—As seen by the figure presented, the chart is composed of three columns, as applied to the contracting profession. Each of them represents one hundred per cent. That makes the chart readable in either percentages of the subjects treated, or in the money amounts which are entered alongside of each space.

The first column stands for the total income of the year, giving a section to each of the various manners in which the income was gained. To the man who is building upon contracts for others exclusively, a single division would suffice. To the man who is engaged in building upon contracts, investing in and building upon real estate of his own for sale, and speculating upon realty as well, there would be a greater number of divisions.

Income.—In the example chosen I am assuming the condition of the man who builds solely upon contracts. This man would have a gross income equal to the moneys received from these contract buildings, plus the return from any sales of dirt, junk, worn machinery, or other items which might arise throughout the year. This gives rise to but two major divisions as shown: the one of Value of Contracts or "Return from Contracts" as noted, and from the "Sales of Junk."

Disbursements.—But all of this income is not his. Much must be paid out for various items, and this gives rise to the second of the three columns. The divisions of this are increased, because the disposition of the income has many more distributive points than has the income itself. Labor is probably the first and greatest item, followed by materials, sales expense, incidentals and profit. The latter, while larger than many other of the items, is left until the last because it should stand out from the remainder of the column.

Equipment and Incidentals.—To the item of disposition of income might be added the one of equipment investment, and also the one of reserve, if such an account is used. These are items which will bring their use in the individual business, and my only desire is to present the average case, leaving the personal application to you.

The item of incidentals is one which might be used as a dumping ground for expenses that could not properly be classified or for business losses which it is desired to hide from the banker. For that reason there was entered the third column which takes care of the disposition of the incidentals fund. This might carry many different accounts, and for that reason I have made it the accumulative account of equipment, repairs, office expenses, sales expense, and non-productive labor. Under the non-productive head I have considered those items which cannot rightly be charged as labor on the contract, yet are essentially an expense item. The account would contain the inspection charges, drafting expense when there is any, and such other items as will present themselves in your particular business.

Chart vs. Balance Sheet.—Now let us look at the charting as a whole. What is presented there that is not shown on the ordinary balance sheet? I cannot definitely say that there is anything. The advantage lies in other channels. Simplicity is the outstanding feature. The figures for the year are taken from the balance sheet and entered into the sketch of the chart. The references that need be made after that time can be better determined from the simplified form presented than from the simplest balance sheet that ever was made by an accountant.

Spread before you are the bare facts of the business, and the unmistakable relation which each holds to the others. No possibility of one item eclipsing another in the matter of use of income, and any departure from the ordinary distribution of funds from year to year becomes an outstanding fact. No one who properly considers the basic facts of his business faces them as individual items. Each has a relation which it bears to the entire business machine. That relation could never be given in a more concise form.

At a glance you may determine the relation of profit to total income; the relation of nonproductive expense to that of the productive. The visualizing of pertinent facts can but bring a more definite thought toward business

betterment and to the rearrangement of methods in such a manner as to offset the facts which show their relation to be out of proportion.

The Banker's Concern.—This has a definite application to the negotiations for a loan. The banker is concerned with the working aspects of your business more than he is with the amount of invested capital. A million dollars of investment is valueless unless there is an adequate return upon it. The man with a thousand dollars of capital who is turning it completely every month has a greater borrowing power than the man with twelve thousand capital who is having a turnover of once a year. It is not the question of how much is invested; but of how the investment is being used.

When you are able to step into the banker's office and lay before him a carefully prepared chart which describes completely the sources of your business income, its distribution down to the smallest item; and still do this within a small and easily read space; you have won his respect at the first glance. He is business man enough to grasp the intimacy of the knowledge which you have of your own business. And he is awake to the fact that such a knowledge makes you a better loan risk than the man with a scattered knowledge.

For One's Own Benefit.—And there is yet another factor of such a knowledge of the characteristics of your business that is valuable to every branch of endeavor in the world—but particularly to that of the contractor. Through the Department of Commerce it is possible to obtain definite information relative to the return upon invested capital, percentage of profit, and other intimate items of contracting in general. These figures are gathered from all over the country and are resolved into the averages which mark the mean line of the profession of every state. If you could be certain that your costs, as related to income or to any other item, stood about the same as or lower than those of the entire profession, you would be able to operate more intelligently and with greater fairness to both yourself and your clients.

To know these facts, and to be able to apply them to your business means the promotion of a greater business efficiency. I know just how mis-used the word efficiency is, but here is a place where it really fits. With the knowledge that your costs are well within the average costs, and that your ratio of expense is equal to or below that of the average, you can place your major effort upon other branches of the business. You can have the knowledge that you are equipped to obtain the necessary funds for every emergency through the clear presentation of your figures in comparison with the average ones. And you are made certain of a respectful hearing from the banker who delights in having a summary that is quickly and easily understood placed before him with a loan application.

Cost of Building in California

The valuation committee of the Southern California Chapter of the General Contractors of America has made a compilation of the present average building costs in that section of the state. The information will be used by the county assessor as an aid in determining the correct valuation of buildings. It will also be used by the mortgage and loan departments of many local banking institutions as a guide to the accurate appraisal of structures. The Dec. 17 News Letter of the Associated General Contractors summarizes the costs as follows:

Class A steel frame buildings—Cost per cubic foot: Office buildings, 53 ct.; hotels, 58 ct.; lofts, 28 ct; warehouses, 25 ct.

Class A reinforced concrete buildings—Cost per cubic foot: Office buildings, 50 ct.; hotels, 55 ct.; lofts, 25 ct.; warehouses, 20 ct.

Class C brick buildings—Cost per cubic foot: Stores or theaters on ground, rooms, apartments, etc., above 33 ct.; apartments, 38 ct.; lofts, 20 ct.; warehouses, 15 ct. One-story garages, per square foot, $1.75; one-story stores, per square foot, $2.25.

Frame buildings—Cost per square foot: California houses, good, $3; medium, $2.50; cheap, $1.75. Bungalows, special, $5 to $6; good, $3.60; medium, $3; cheap, $2.50. Bungalows, out of town (no restrictions), good, $3.75; medium, $2.75; cheap, $2. Residences, two-story, good, $6 to $8; medium, $4.50; cheap, $3. Outbuildings, good, $2 to $2.50; medium, $1.70; cheap, $1. Corrugated-iron buildings, all kinds, approximately, $1.

Index Numbers of Wholesale Prices

An "index number" is really a percentage, and in the case of an "index price" shows the relative price level at different times. In the accompanying table the price level, or "index price," is 100 for the year 1913; and the indexes for other periods are those calculated by the U. S. Department of Labor.

In previous issues it has been stated that the index of building materials did not include steel. This is in error, as the revised index is a weighted average of the principal building materials, including steel and certain other metals. All figures given in this table are in accordance with the revised calculation.

	Farm products.	Foods.	Cloths and clothing.	Fuel and lighting.	Metal and metal products.	Building materials.	Chemicals and drugs.	House furnish'g g'ds.	Miscellaneous.	All commodities.
1913	100	100	100	100	100	100	100	100	100	100
1914	103	102	98	93	85	92	101	100	95	98
1915	104	105	98	88	99	94	134	100	95	101
January	104	106	94	87	82	88	108	99	99	98
July	104	104	96	81	106	94	130	100	94	100
October	106	102	101	94	105	98	151	100	93	102
1916	123	121	127	126	162	120	181	106	121	127
January	110	109	110	113	133	110	84	103	110	113
April	113	114	118	120	164	120	200	104	110	121
July	117	117	125	121	158	120	175	107	120	123
October	136	134	137	128	164	124	164	109	132	136
1917	190	167	175	169	231	157	202	125	148	177
January	152	149	158	171	198	138	173	118	149	153
April	184	164	164	164	230	155	186	121	153	173
July	196	169	181	176	292	168	205	129	153	188
October	207	180	185	153	207	156	231	130	142	183
1918	218	188	228	170	187	172	215	153	156	194
January	211	182	201	164	183	161	223	137	145	184
April	213	181	220	166	184	169	228	144	152	190
July	217	185	238	175	189	177	209	159	159	196
October	225	198	245	176	192	177	211	164	163	202
1919	231	207	253	181	162	201	169	184	175	206
January	224	203	220	178	175	176	181	167	166	199
April	230	205	205	177	153	169	160	167	160	199
July	241	210	262	181	160	209	167	183	177	212
October	227	205	291	189	162	229	173	194	187	211
1920	218	220	295	241	192	264	200	254	196	226
January	247	231	329	194	175	274	189	239	194	233
April	243	238	316	231	193	300	210	242	206	245
July	233	238	300	259	202	269	212	275	203	241
October	187	201	245	280	191	240	198	271	188	211
1921	124	144	180	199	129	165	136	195	128	147
January	143	162	196	247	153	192	153	217	154	170
April	117	144	176	205	138	167	135	216	130	143
July	119	141	172	186	124	160	129	180	123	141
August	123	146	171	184	117	156	129	179	119	142
September	124	142	178	181	116	156	131	179	118	141
October	124	140	180	189	116	159	131	180	118	142
November	121	139	180	197	114	163	129	178	119	141
December	120	136	180	199	113	158	127	178	121	140
1922	133	139	180	220	122	169	124	176	117	149
January	122	131	176	195	112	157	124	178	117	138
April	129	137	171	194	113	156	124	175	116	143
May	132	138	175	216	119	160	122	176	116	148
June	131	140	179	225	120	167	122	176	114	150
July	135	142	180	254	121	170	121	173	114	155
August	131	138	181	271	126	172	122	173	115	155
September	133	138	183	244	134	180	124	173	116	153
October	138	140	188	226	135	183	124	176	120	154
November	143	143	192	218	133	185	127	179	122	156
December	145	144	194	216	131	185	130	182	122	156
1923—										
January	143	141	196	218	133	188	131	184	124	156
February	142	141	199	212	139	192	132	184	126	157
March	143	143	201	206	149	198	135	185	127	159
April	141	144	205	200	154	204	136	187	126	159
May	139	144	201	190	152	202	134	187	125	156
June	138	142	198	186	148	194	131	187	123	153
July	135	141	193	183	145	190	128	187	121	151
August	139	142	193	178	145	186	127	183	120	150
September	144	147	202	176	144	182	128	183	121	154
October	144	148	199	172	142	182	129	183	120	153
November	146	148	201	167	141	181	130	176	113	152

Retail Prices of Building Materials

Average prices paid Nov. 1, 1923, by contractors for building materials delivered on the job. These prices are secured through the Bureau of the Census and published monthly by the Division of Building and Housing of the Bureau of Standards, United States Department of Commerce.

The report as published by the Division of Building and Housing gives prices at 42 cities, 28 of which are included in the table herewith. Boston, New York, Philadelphia, Chicago and San Francisco are among the places not listed in the Bureau's report for Nov. 1.

Item No.	Commodity. Size and condition.	Unit.	Haverhill, Mass.	New London, Conn.	Poughkeepsie, N. Y.	Rochester, N. Y.	Buffalo, N. Y.	Baltimore, Md.	Richmond, Va.	Columbia, S. C.	Savannah, Ga.	New Orleans, La.
1.	Common brick	1,000	$24.00	$27.00	$20.00	$17.75	$23.00	$20.00	$19.00	$12.00	$14.00	$17.75
2.	Portland cement, excl. of containers	Bbl.	3.60	3.60	3.30	3.35	3.03	2.85	3.50	3.65	3.00	3.00
3a.	Yellow pine, No. 1, dimension 2x4—16 ft., S1S1E	M	.....	.....	.....	48.00	55.00	40.00	32.00	.....	30.00	40.00
3b.	Douglas fir, No. 1, dimension 2x4—16 ft., S1S1E	M	.....	.....	45.00	56.00	60.00	.....	.....	.....	.....	.....
3c.	N. Carolina pine, No. 1, dimension 2x4—16 ft., S1S1E	M	.....	.....	.....	48.00	.....	.....	.....	25.00	.....	.....
4.	Common boards, No. 1, 1x6	M	55.00	45.00	38.00	45.00	50.00	40.00	35.00	25.00	30.00	45.00
5a.	Y. P. flooring edge, grain "C," 1x4—10 ft.—16 ft	M	130.00	.....	102.50	130.00	.....	.....	102.00	100.00	.....	.....
5b.	Douglas fir V. G., No. 2, 1x4—10 ft.—16 ft	M	.....	.....	.....	.....	115.00	.....	.....	.....	.....	.....
6a.	Red cedar shingles, extra clear, 16 in., 5 to 2	100 sq. ft.	6.40	6.00	5.60	6.00	6.75	11.20	6.00	.....	.....	.....
6b.	Cypress shingles, extra clear, 16 in., 5 to 2	100 sq. ft.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6c.	Composition shingles, crushed slate surfaced	100 sq. ft.	8.00	.....	6.50	.....	.....	6.00	.....	6.50	6.25	.....
7.	Gypsum plaster board, ⅜ in	1,000 sq. ft.	50.00	50.00	.....	30.00	45.00	32.50	40.00	35.00	.....	45.00
8.	Lime, HYD, com	Ton	20.00	26.00	24.00	20.00	16.00	15.00	17.50	20.00	17.50	.....
9.	Building sand	Cu. Yd.	2.50	1.65	2.50	2.25	1.28	2.50	2.40	1.25	.....	2.00
10.	Crushed stone, ¾ in	Ton	2.50	.....	3.00	2.25	1.30	.....	3.60	2.75	4.40	3.25
11.	Wire nails	Keg	5.00	5.05	5.05	4.25	4.25	3.75	4.05	4.25	3.95	3.80
12.	Window glass, single A, 10x12 in	50 sq. ft.	.....	4.27	.....	4.20	4.20	.....	5.80	.....	.....	4.34
13.	Hollow tile, 8x12x12 in	Each	.30	.32	.23	.21	.21	.24	.....	.17	.....	.23
14.	Cast iron soil pipe, 4 in. E. H., 12 lbs. per ft	Ton	.....	.....	.....	66.17	63.05	62.00	62.80	.....	.....	.....
15.	Steel pipe, 1 in. galv	100 ft.	.....	.....	.....	10.52	10.00	9.88	9.63	11.37	9.46	9.53
16.	Reinforcement bars, ¾ in. square	100 lbs.	.....	.....	4.50	3.60	2.75	3.55	3.35	4.60	5.00	3.75
17.	Structural steel, fab. 6 in. I beams	100 lbs.	.....	.....	5.00	4.50	3.65	3.75	4.50	5.00	5.00	3.90
18.	White lead, dry	100 lbs.	14.00	14.50	.....	12.60	14.00	.....	.....	14.75	14.75	12.50
19.	Zinc oxide, Am. process lead free	100 lbs.	.....	.....	.....	.....	.....	.....	.....	20.00	20.00	.....
20.	Gypsum plaster, neat	Ton	.....	26.00	.....	18.00	17.00	19.50	20.00	20.00	21.50	21.00
21.	Linseed oil, raw, in bbls	Gal.	11.05	1.35	.....	1.05	1.12	.95	1.03	1.20	1.05	1.00
22.	Roofing slate, No. 1 ribbon	100 sq. ft.	.....	.....	.....	15.00	.....	.....	13.50	.....	.....	16.00
23.	Tar paper, roofing, 2-ply, 75 lbs. per roll of	100 sq. ft.	2.75	.....	.....	2.25	2.00	.....	.....	.....	1.95	.....
24.	Rosin sized sheathing, 3-ply, 30 lbs. per roll of	500 sq. ft.	1.70	.....	.....	1.25	1.50	1.75	1.50	.....	.....	.....

	Pittsburgh, Pa.	Cleveland, O.	Newark, O.	Dayton, O.	Detroit, Mich.	Bay City, Mich.	Milwaukee, Wis.	Waterloo, Ia.	Des Moines, Ia.	Kansas City, Mo.	Grand Forks, N. D.	Shreveport, La.	San Antonio, Tex.	Tucson, Ariz.	Los Angeles, Calif.	Seattle, Wash.	Portland, Ore.
1.	$17.00	$16.00	$18.00	$15.50	$17.50	$18.00	$13.50	$16.50	$19.00	$16.50	$15.00	$15.00	$14.50	$12.50	$15.50	$18.00	$20.00
2.	2.85	.....	3.40	3.12	.....	2.90	2.66	3.00	3.40	2.90	3.80	3.20	3.60	3.80	3.36	3.00	3.25
3a.	50.00	56.00	50.00	55.00	.....	50.00	42.00	52.00	52.00	49.00	.....	46.00	57.00	.....	.....	.....	.....
3b.	.....	.....	.....	.....	.....	.....	.....	50.00	52.00	49.00	45.00	.....	.....	62.00	41.50	21.50	24.50
3c.	.....	.....	.....	.....	.....	.....	52.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4.	47.00	40.00	47.50	.....	.....	46.00	.....	47.00	56.00	50.00	44.00	50.00	66.00	57.50	40.00	21.50	24.50
5a.	.....	90.00	90.00	90.00	.....	90.00	85.00	95.00	106.00	95.00	.....	97.00	120.00	.....	.....	.....	.....
5b.	.....	.....	.....	.....	.....	.....	.....	95.00	95.00	85.00	95.00	.....	.....	95.00	82.75	56.00	58.00
6a.	6.25	6.00	6.50	6.20	5.30	7.00	5.75	6.50	6.50	4.75	6.00	.....	6.00	.....	4.06	3.50	.....
6b.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.75	6.80	.....	.....	.....	.....
6c.	.....	.....	6.50	6.50	6.35	6.00	6.50	7.50	6.00	.....	.....	7.70	7.60	.....	.....	.....	.....
7.	37.50	32.00	45.00	32.50	30.00	40.00	42.00	36.00	40.00	32.50	.....	45.00	47.50	50.00	34.00	35.00	40.00
8.	23.00	18.00	18.00	16.00	20.00	16.00	.....	20.00	20.00	.....	25.00	25.00	20.00	.....	26.50	22.00	26.00
9.	2.50	2.50	2.50	1.75	2.75	2.50	2.25	1.75	2.00	1.80	3.00	2.25	2.20	1.25	1.75	1.75	2.60
10.	5.50	3.50	.....	2.75	2.35	3.60	2.67	3.50	4.30	2.00	.....	4.32	2.60	3.00	3.10	.....	.....
11.	3.50	.....	3.80	4.10	4.25	3.85	3.80	4.50	4.25	4.20	5.50	4.60	6.30	6.00	4.50	4.35	4.50
12.	.....	.....	4.00	4.50	5.00	5.00	4.75	5.25	4.75	4.50	.....	5.10	4.50	.....	4.38	4.00	5.00
13.	.20	.....	.19	.21	.20	.18	.17	.17	.....	.17	.....	.22	.22	.18	.20	.20	.....
14.	55.00	.....	70.00	.....	65.39	85.00	97.00	82.00	90.00	.....	92.40	106.25	80.21	.....	.....	91.40	.....
15.	9.86	.....	10.40	10.50	8.60	9.75	12.50	12.00	11.50	11.20	.....	11.95	12.36	14.50	12.35	12.78	.....
16.	4.00	.....	.....	.....	4.25	3.65	3.25	4.00	3.25	.....	.....	4.00	4.00	4.50	4.25	3.00	4.00
17.	3.25	.....	.....	4.50	6.50	4.70	6.25	4.95	5.00	3.80	.....	6.50	4.50	.....	6.00	6.00	5.50
18.	14.00	14.00	13.50	14.00	14.00	13.00	.....	14.50	14.50	14.50	18.00	15.00	15.50	15.50	12.50	13.25	.....
19.	15.00	.....	.....	15.00	.....	19.00	.....	19.00	14.75	12.00	.....	.....	16.00	.....	.....	19.00	.....
20.	22.00	.....	18.50	18.00	.....	17.50	.....	18.00	18.00	18.00	27.00	24.00	22.00	23.00	.....	21.00	24.00
21.	.91	1.05	1.00	1.01	1.05	1.15	1.07	1.30	1.20	1.16	.....	1.35	1.05	1.12	1.10	1.07	1.25
22.	13.50	.....	13.50	15.00	.....	17.00	.....	18.00	18.00	.....	.....	12.00	17.60	.....	.....	.....	.....
23.	1.95	2.50	2.25	2.25	2.75	2.75	.....	3.25	3.00	.....	.....	2.75	3.15	3.50	3.75	.....	.....
24.	1.35	.90	1.20	1.50	.....	1.15	.....	1.50	1.40	.....	2.00	1.40	1.60	1.75	1.50	1.20	11.80

Pittsburgh Steel and Iron Prices

The following data on prices and freight rates are taken from The Iron Age of December 13.

Plates, sheared, tank quality, base, per lb.	2.50c
Beams, channels, etc., base, per lb.	2.50c
Soft steel bars, base, per lb.	2.40c
Reinforcing steel bars, base, per lb.	2.40c
Track spikes, 9/16 in. and larger, base, per 100 lbs.	3.00-3.15
Track spikes, ½ in. and smaller base, per 100 lbs.	3.15-3.25
Spikes, boat and barge, base, per 100 lbs.	3.25-3.50
Track bolts, ¾-in. and larger, base, per 100 lbs.	4.00-4.25
Tie plates, per 100 lbs.	2.55-2.60
Angle bars, base, per 100 lbs.	2.75
Butt welded steel pipe, ¾-in.—Percentage discount—Black 60; galv.	48½
Butt welded steel pipe, 1 to 3 in.—Percentage discount—Black 62; galv.	50½
Lap welded steel pipe, 2½ to 4 in.—Percentage discount—Black 57; galv.	46½
Pig iron, No. 2X, Philadelphia, per gross ton	$24.96
O.h. rails, heavy, at mill, per gross ton	43.00

Freight Rates

All rail freight rates from Pittsburgh on domestic shipments of finished iron and steel products, in carload lots, to points named, per 100 lbs., are as follows:

Philadelphia	$0.32	St. Louis	$0.43
Baltimore	0.31	Kansas City (pipe)	0.705
New York	0.34	St. Paul	0.60
Boston	0.365	Omaha	0.735
Buffalo	0.265	Omaha (pipe)	0.705
Cleveland	0.215	Denver	1.27
Cleveland, Youngstown, comb.	0.19	Denver (pipe)	1.215
Detroit	0.29	Pacific Coast	1.34
Cincinnati	0.29	Pac. Coast ship plates	1.20
Indianapolis	0.31	Birmingham	0.58
Chicago	0.34	Memphis	0.56
		Jacksonville, rail and water	0.415

Concrete and Creative Architecture

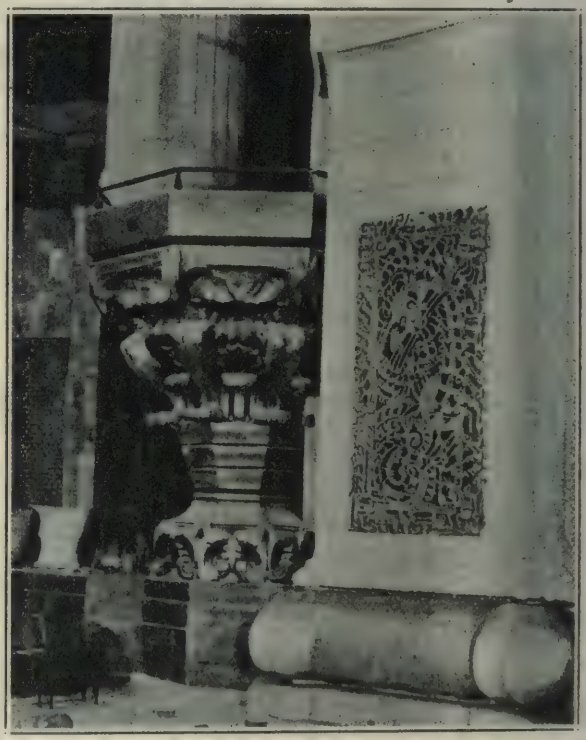
Essentials in the Artistic Use of Concrete and Other Materials Discussed in The Architect and Engineer by the Designer of Grauman's Metropolitan Theater, Los Angeles

By WILLIAM LEE WOOLLETT,
Architect

In creating a new art, a new law is not established. The principles of orderly arrangement of the æsthetic values are not jeopardized but vindicated. When a new material for building arrives on the arena of human endeavor there is not a general abdication of the theses upon which all good architecture of the past has builded itself. Rather there is a gathering of the clans; "analysis" and "research" gird themselves in respect to the laws of building as they have been applied in all the ages. Out of this advent of a new building material comes finally—after many a misapplication of the "eternal laws"—a true solution of the problem—an acceptable adaptation of the new material to the building use to which it is assigned.

Good architecture results, not from blindly copying the ancients but from the nice balancing of the form, texture and color of building materials to their structural or static value. A porous, pliable or crumbling stone is a poor building material, no matter what its charm of color or texture. An ill-shaped moulding of stone, no matter what its charm of color and texture or its strength and durability, is not the proper thing to build into a structure when beauty is required; and so we see that down through the ages there has developed a correspondence of values, a recognized relation between structural use to which a material is put, and the color and the form and texture.

We do not build costly, precious colors into buildings used for menial purposes. We do use refined and elegant mouldings in marble and bronze, for the building of temples and churches and homes. We do use wrought iron and rough-hewn stone and great husky mouldings of granite or sandstone in a prison or castle wall. A Gothic church hewn out of solid rock, like the rock-cut tombs of the Nile, would have no charm, no matter how wonderfully wrought, because the power of balanced forces would not be there. The "structural æsthetics" of the building would be nil.



Exxedra and Grille Near Proscenium Arch, All Constructed of Concrete, Grauman's Metropolitan Theater.

The structural æsthetic value of the column and lintel, the structural æsthetic value of the arch, round and pointed, represent a series of conclusions as to structure with which civilized man has toyed now for some thousands of years.

Presto! There is a new building material—reinforced concrete! This new material spans spaces which make the spaces between the Greek temple columns look very small; it arches itself over rivers and rises into the air until the birds go up to meet its airy towers; it dams the torrents in bulk equaling the bulk of the Pyramids.

Its ancient prototype we do not know.

Like the solid rock and the granite and sand stones of the Nile, this new material will in due time be shaped, formed and colored to meet the æsthetic requirements of the age in which it plays a part so important.

And so, when this material is so shaped and adjusted, and the building in which it plays a part is completely in rhythm with itself, we shall have a new phase of the building art. And then, if beside a new material, a new philosophy, a different basis of thought is ripening in the world, we shall find these other new elements asserting themselves in the buildings.

Symbols are the easiest way for builders to express the thoughts which dominate them. Therefore, we find in architecture a more or less highly expressive symbolism depending on the point of view of the builder. The Gothic architecture of the Christian Church is very full of symbolism; the architecture of the modern dissenting church is almost devoid of symbolism. The superficial styles of Napoleon and Louis VIII are quite empty, and modern French is dead as regards this rich and eloquent element.

But there is a deeper and a more scientific way to express the philosophy of the builder—in the structural æsthetics, i. e., in the relation of the static forces to the forms employed. When you undercut a bit of marble moulding to the point where a hair deeper would make the mould look weak and inadequate, but you leave it just at the point where it looks strong, yet refined and elegant, you are a craftsman of no mean order. You are drawing a line on your building which must in weight and color hold its proper place in the computation of the whole. You are estimating the quality of your material as to ultimate strength, friability or cohesive co-efficient. As well, you are labeling the particular block of marble in such a manner as to disclose its true function as a part of the structure, i. e., something which has been put together with human hands, one stone upon another—and the very act of building must be honored in the final result. That is why the Greeks preferred to build their temple columns in drums rather than from single pieces of stone. The Greeks rarely used excessively large pieces of stone, as did the earlier Myscenians.

The philosophy of the builder must be expressed in these structural values. Such values have to do also with the science of numbers. To illustrate: The complex, highly-educated mind will see his sequences (egg and darts, lintels, promenades, bean spaces, etc.) in geometrical and arithmetical ratio, whereas the primitive mind will see his sequences in much the same way as the elemental man saw them, through the rule of three.

In building the geometrical and arithmetical sense of our civilization into our buildings, we must remember that just at present the average mind in America, for instance, is far below the average mind of those selected groups of the past, like the Greeks whose intellectual capacity is now gauged by what we call good architecture. In our day the masses play a considerable part in selecting, judging and creating architecture, whereas in the great architectural periods in the past the forces of creation were limited to a comparative few. In the Gothic period, for instance, a priesthood limited in number dominated the lay mind in every way and pleased itself only as regards the building of the period.

In all ages of the past—I am speaking now of great epochs and not of isolated examples—except perhaps in the time of Grecian supremacy, the system of authority has been so concentrated as to enable a collective few to dominate the æsthetic impulses.

I have often heard the harmonies

of Liszt, Chopin, Wagner and others variously rendered. One may recognize the author if one has merely a musical memory, and of course the rendering always differs according to the personality and intelligence of the performer. In like manner I have seen the beautiful capital of the Choragic monument "variously rendered." I have never seen two copies of this capital which were sufficiently alike as to defy my powers of analysis, and I have often thought in respect to this particular beautiful specimen of Greek art, that with no Greek to carve —and no Greek to appraise the results —it is highly improbable that a work of pure Greek architecture could be created at this time. The impossibility of creating or recreating any dead art is as palpable as is the impossibility of creating in duplicate any master painter's or master sculptor's work. The act of creating and copying is essentially different. A copy in the realm of art is recognized as not having the true value of an original. By the same token, a work of art or architecture, worked up in the spirit of a bygone age, is minus, perforce, the essential art values of a creative work.

The creative in architecture is the element which above all others signalizes the artisan spirit, as opposed to the mere commercial or mechanical act of building. It is the artisan spirit which recreates out of suggestive forms of dead and bygone ages new and living forms, thus detonating ideas and ideals. It is the artisan rather than the engineer or master builder who first sees in a new material an inspiration to modify the technique of æsthetic in building. He has learned to employ certain forms in older and tried materials. Out of the pioneer spirit of the artisan we see new buds and flowers of beauty growing out of every art, to meet the spirit of the age in which he lives.

And so when one says to the modern architect: "Why do you blend motifs from the different historical styles of architecture?" the answer is: "These old forms are beautiful and suggestive of every phase of human thought. These forms are the 'language' of the architect. He has no other. In designing a building with the idea that the building shall tell the story of its use or occupancy, and especially in attempting to tell this story in a new building material, the language of form utilized is necessarily the language in which all architectural form has spoken in the past. It would be an unforgivable imposition, nevertheless, to cast an exact copy of a Greek temple out of concrete or a Gothic cathedral or a Colonial house in this new material. Some measure of intelligence must be exercised in adaptation—some imagination spent—some spirit of play in evidence. The building of these old forms in concrete would be absolutely dead and repulsive without the application of the adaptive spirit of the artisan. We can well imagine that in using concrete, to tell the tale of "power" and "dignity," unbroken wall surfaces in this basic material would be sufficient, perhaps, if in some subtle way to these areas should be added a hint of the ancient architecture. To spell the refinement and cultural values to which we are heir, the balanced fineness of Greek moulds and columns will suffice. To detonate the playful spirit, a whif of Louis XIV or Churrigueresque—to background the whole with a vague suggestion of paganism by employing some simple motif of Tuscan or Aztec—to tell, in short, the story of the building in a language of abstract and subconscious values, which are inherent in the architecture of the past. These motifs used in juxtaposition to each other and as antithesis for each other, stimulate the intellect, move the emotions and renew in man the spirit of the dead, but still daring and pioneering past.

This is one way of viewing creative architecture.

National Forestry Policy Bill Before Congress.—A bill intended to provide the foundation of a general American forestry policy has been introduced in the U. S. Senate. The bill is essentially of the fifty-fifty national and state co-operative class, but unlike the existing Weeks' law, its provisions are not confined to the watersheds of navigible streams. The secretary of agriculture is directed, in co-operation with state officials and other agencies, to recommend systems of forest fire prevention and suppression for each forest region of the United States, with a view to the protection of forests and water resources; and the continuous production of timber on lands chiefly suitable for that purpose.

A New Detachable Weatherstrip

The character and manner of attachment of "Wirfs' Home Comfort Insulated Detachable Weatherstrip" are all illustrated in the accompanying views. It comes in continuous length, rolled. According to the maker, Mr. E. J. Wirfs, 124 South 7th St., St. Louis, Mo., it is waterproof, being made of pure rubbercoated fabric, impervious to moisture, en-

Cross Section of Door, Jamb and Weatherstrip.

closing and protecting the insulation, preventing crystallization and decay.

It is airthight, and when in place forms a resilient caulk or fillet, similar to refrigerator door seals.

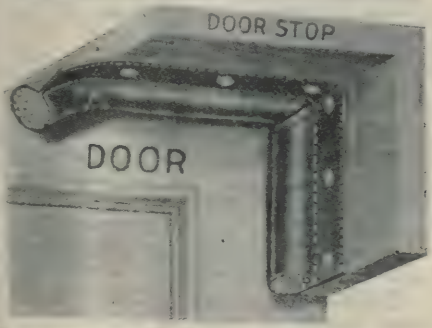
It is flexible, never hardens, cracks nor tears and is adjustable to varying surfaces, warped doors, 90-degree angles, etc., without cutting.

It is noiseless, as it has vibratory absorption, that is, a cushion effect on slamming doors and rattling windows.

It is readily detachable.

It is dustproof, sealing the doors and windows against dust, vapors, etc., as well as against wind, rain, snow and sand.

It is nonconductive. While metal weatherstrip when applied perfectly



Weatherstrip Applied to Door.

may keep the wind out, it does not resist the "cold," since metal is a rapid conductor of heat or cold. "Home Comfort Weatherstrip" is insulated, thus greatly lessening the transfer of heat or cold through joints.

This weatherstrip was first made by its present manufacturer for the sealing of refrigerator doors, but in time it came into demand for weatherstrip purposes, and as stated, is now manufactured definitely for that use. It is made in standard maroon color for general purposes, and in white where desired for white enameled woodwork.

Machine Lays 1200 to 1500 Brick Per Hour and Leaves Correct Window and Door Openings

A "filler" in our November 28th issue told very briefly of a brick laying machine recently invented by a Scotchman. We now give the following more detailed account as printed in the British paper, "The Ironmonger."

Few trades connected with housing have given rise to more discussion than that of bricklaying, and it is still an unsolved problem how many bricks a competent English bricklayer ought to lay in a working day. Figures varying between 200 and 800 have been suggested, but hitherto it has only been possible to compare one man's work with another's. Now, however, after five years of experimenting, a machine for laying bricks has been perfected. The "K" erector, as it is called, is made by Sir Wm. Arrol and Company (Ltd.), of Glasgow, Scotland, and is being used on a housing scheme in the Glasgow area. It consists of tubular uprights, connected at top and bottom, and free to travel on rails laid along the outside walls. Across the width of the house to be built, and carried on the uprights, is a boom which can be raised and lowered. On it are mounted a small traveling carriage, the mortar tank, and the bricklaying mechanism. With the last-named over the starting point the laying wheel rotates, taking two bricks at a time from the hopper, while the measuring mortar wheel spreads the mortar. Thus, as the carriage moves across the boom, one row of bricks is laid.

When the end of the wall is reached the direction of the carriage can be changed, and the movement of the machine adjusted so as to lay bricks along one of the side walls, and then across the back and up the other wall to the point where the work was started. After a course has been laid all around, the boom has to be raised

by the thickness of one brick, plus the mortar joint, and the operations are repeated until the desired height is reached. Provision is made for automatically cutting off the supply of brick and mortar wherever a doorway or window intervenes. The feeding of the brick into the hopper is best performed by hand, and the speed at which the machine lays them is regulated thereby. The average is said to be between 1,200 and 1,500 brick per hour. Three men are required to work and feed the machine, and the most suitable driving power is a three-horse power electric motor; but where current is not available a small petrol engine can be fitted to the traveler.

A Study of the Factors Affecting the Life of Boiler Setting Refractories

The need has been felt for a long time of a better test covering the resistance of boiler setting refractories to slagging. Although the investigations which the U. S. Bureau of Standards have carried out on refractories for the development of specifications have shown that the service can be predicted with fair accuracy from the results of certain tests, it seems desirable to develop a laboratory slag test in order that factors of composition, both of the slag and their comparative effect on the life of brick may be determined. The apparatus necessary for carrying out such a test has been designed and constructed and it is proposed to observe the effect of high, medium and low fusing clinker on various brands of refractories. Test panels of the brick to be investigated will be brought to a high temperature by means of a blast impinging on the brick. Finely ground and artificially prepared clinker will be introduced into the flame and in this way brought into contact with the test panel.

Apprentice Training at Carnegie Tech.—The Pittsburgh local of the International Wood, Wire and Sheet Metal Lathers Union has effected a working agreement with Carnegie Tech whereby the union apprentices to the union will be trained there. As a result of this agreement, 15 apprentices have been recently enrolled at the institute and are compelled by the union to attend night school classes three nights a week for the next two years.

Apartment House With Full Electrical Equipment

The Journal of Electricity gives the following account of the Huntington Apartments now under construction in San Francisco and of the electrical installation included:

The building, plans for which were prepared by Weeks & Day, San Francisco architects, is fireproof throughout and one of the most beautiful apartment houses yet erected in this section. It will be twelve stories high on California Street and fifteen stories on Pine Street with garage in the basement. Electricity plays a very important part in the operation of the entire building as the elevators will be electrically operated; each kitchen will be wired for an electric refrigerator; an electric suction fan on the roof will provide kitchen ventilation; motors will be installed for operation of vacuum cleaners, circulating hot water system and fire pump; three convenience outlets will be wired into each room; lighting fixtures will be specially designed for the purpose of diffusing all light from the center of the room and every kitchen will be equipped with a Simplex electric range. The cost of the building complete will be approximately $1,600,000 and it will be ready for occupancy within a few months.

Manual of Standard Wood Construction

What is said to be the most complete timber handbook ever published is the recently issued manual of the Southern Pine Association of New Orleans. This is the 9th edition, and has been substantially revised and enlarged from the previous edition.

The new material added includes:

The latest requirements for floor and roof loads of the largest cities distributed over the various sections of the country.

New material on wood block floor and paving construction.

Details for design of light wood roof trusses on spans up to 15 ft.

Timber working stresses and design factors based on recent comprehensive tests of commercial material.

Safe working loads for bolted, nailed and spiked connections.

Actual size, 4½ x 6¾ in.; 186 pages. Price $1.50.

Bids Asked

Roads - Streets

ALA., BIRMINGHAM—Until Jan. 2nd by City Commissioners, for paving of First Ave., between 4th and 4½ th St., A. J. Hawkins, City Engineer.

CAL., LOS ANGELES—Until 12 Noon, Jan. 3rd, by Board Library Directors, Metropolitan Bldg., for preliminary excavation, removal and deposition of material and rough grading, for the Central Public Library, Normal Hill, 5th and Grand Ave., Los Angeles.

CAL., OROVILLE—Until Jan. 7th, by Board of Supervisors, for grading portion of the Oroville-Quincy road, cost $30,000.

CAL., SACRAMENTO—Until 2 P. M., Jan. 7th, by California Highway Commissioners, 515 Forum Bldg., Sacramento, for 1.9 miles highway, paved with portland cement concrete.

LA., BATON ROUGE—Until Jan. 3rd, by Louisiana Highway Commissioners, Reymond Bldg., for constructing of Louisiana Federal Aid Project No. 135-A, Richland Parish, 0.95 miles; J. M. Fourmy, State Highway Engineer.

LA., BATON ROUGE—Until Jan. 3rd, by St. Landry Parish, Boggs-Palmetto Highway, for gravel for surfacing; J. M. Fourmy, State Highway Engineer.

MINN., CARLTON—Until 10 A. M., Jan. 8th, by Carlton County, Oscar W. Samuelson, County Auditor, for graveling State Aid Road 6 from intersection with State Road 2, then S. and E. ¾ mile; about 900 yd. gravel.

MINN., ST. PAUL—Until 2 P. M., Jan. 2nd, by H. W. Austin, Purchasing Agent, City Hall, for grading and improving boulevard across narrows in Como Lake from Driveway on West Shore to Driveway on East Shore.

MISS., JACKSON—Until 12 Noon, Jan. 8th, by County, for $50,000 county paving and bridge project; W. B. Montgomery, Engineer in charge.

MO., JEFFERSON CITY—Until 8 P. M., Jan. 7th, by City, H. A. Nall, Clerk, for approximately 200 sq. ft. concrete sidewalk in Washington Park Addition, West side Ohio St., between St. Mary's Blvd. and Dunklin St.; F. E. Ross, Engineer.

MO., KANSAS CITY—Until 2 P. M., Jan. 3rd, by Board Fire and Water Commissioners, Fred Turner, President, for grading for a railroad siding about ¾ mile long and a relocated electric railroad and highway about 4/5 mile long including a re-concrete highway bridge span 16 ft., width 18 ft., located just north of North Kansas City; Fuller & Maitland, 201 Walsix Bldg., Engineers.

MO., RICHMOND HEIGHTS—Until 8 P. M., Jan. 2nd, by G. H. Skillman, City Clerk, 7409 La Veta Ave., for grading, paving and improving Bellevue Ave.

OKLA., DAVIS—Until Jan. 10th, by City, E. T. Archer & Co., 609 New England Bldg., Kansas City, Mo., Consulting Engineers, for concrete paving.

OKLA., WAURIKA—Until 7:30 P. M., Dec. 28th, by City, care of Bobbie McGuire, Clerk, for paving, 3,229 yd. 2½ in. vitrified brick paving in District No. 3; F. E. Devlin, 614 Bitting Bldg., Wichita, Kan.

ORE., OREGON CITY—Until 11 A. M., Jan. 2nd, by County Court of Clackamas County, Ore., for grading of part of Market Road No. 5; H. E. Cross, County Judge.

PA., SCRANTON—Until 8 P. M., Dec. 28th, by G. E. Haak, Superintendent uildings and Supplies, Administration Bldg., for filling, cutting and grading of yard at North Scranton Junior High.

WASH., OLYMPIA—Until Jan. 8, by Washington State Highway Commission, for clearing 50 mile right of way of Olympic Highway, between Bogachiel and Queets rivers.

WIS., SUPERIOR—Until 2 P. M., Jan. 3rd, by Douglas County Road and Bridge Commissioners, at Court House, Superior, Wis., for graveling state trunk highway No. 10, 5 miles, and No. 11, 7 miles, gravel for both projects to be crushed and screened to 1 in. material.

Bridges

FLA., DE LAND—Until 10 A. M., Jan. 3rd, by Board County Commissioners, Volusia County, office of Clerk Circuit Court, for construction of steel drawbridge with concrete pivot pier and creosoted pile trestle bent approaches and draw pier fenders over Indian River, at New Smyrna, Fla.

IA., INDIANOLA—Until 1:30 P. M., Dec. 28th, by Warren County, R. E. Boyle, Engineer, for bridge lumber, 5,420 ft. cypress piling, 203,000 ft. fir bridge lumber, 110 posts.

IA., INDIANOLA—Until 1:30 P. M., Dec. 28th, by Warren County, J. C. Hendrickson, County Auditor, for 5,420 ft. cypress piling 203,000 ft. fir bridge, lumber, 110 posts; R. E. Boyle, County Engineer.

MINN., OWATANNA—Until 2 P. M., Jan. 8th, by Steele County, Geo. Griffin, County Auditor, for 1,382 ft. 15 in. to 36 in. corrugated metal culvert pipe, class A.

MO., KANSAS—Until Jan. 15th, by Board of Public Works, for a steel and re-enforced concrete bridge over Blue River at Independence road; Robt. W. Waddell, City Engineer.

S. D., KENNEBEC—Until 2 P. M., Jan. 2nd, by Lyman County, Gina Kieffer, County Auditor, for constructing one new 105 ft. spand and moving two 175 ft. spans from site of Iona-Oacoma bridge across White river to new site in N. W. quarter of Sec. 17.

WASH., SEATTLE—Until 10 A. M., Jan. 11th, by Board of Public Works, office C. B. Bagley, Secretary, County City Bldg., for construction of concrete viaduct joining W. end of W. Spokane St. bridge.

Drainage - Irrigation

CAL., MODESTO—Until 2 P. M., Dec. 28th, by Modesto Irrigation District at Modesto, for drilling wells and furnishing and erecting drainage pumping plants—12 installations, each comprising well motor-driven deep well turbine pump, motor started and sheet pump-house.

COLO., GRAND JUNCTION—Until 10 A. M., Jan. 2nd, by Grand Junction Drainage Disctrict, Room 200 Fair Bldg., for construction of portion of drainage system; J. H. Rankin, Secretary District.

FLA., TALLAHASSEE—Until 12 Noon, Jan. 4th, by State Road Dept., for constructing drainage structures on Project No. 563, Road No. 2, J. L. Cresap, State Highway Engineer.

IND., CROWN POINT—Until 9 A. M., Jan. 5th, by John J. Wise, Superintendent Construction, of Beaver Dam Ditch No. 3, Court House, for construction of Beaver Dam Ditch No. 3.

TEX., FREEPORT—T. J. Arrington, and A. K. Warters and R. E. Bradshaw, Commissioners, San Bernard Drainage, District No. 9, receiving bids for clearing, ditching and excavating in establishing drainage for which bonds of $24,000 have been approved.

WASH., CASHMERE—Until 10 A. M., Dec. 31st, by C. M. Zediker, Project Manager, Icicle Irrigation Project, Chelan County, for furnishing materials and erecting 2 pipe lines known as the Wenatchee River and Maxwell siphons, 5444 lin. ft. of 30 in. and 545 lin. ft of 28 in. pipe.

Waterworks

CAL., BURBANK—Until 7 P. M., Jan. 8th, by Board of Trustees, office of City Clerk, for furnishing and installing material and labor, drilling of well, 150 to 200 ft. deep.

CAL., BURBANK—Until 7 P. M., Jan. 8th, by Board of Trustees of City, office City Clerk, for furnishing and installing of material and labor for one pitless pump or deep well centrifugal turbine pump.

CAL., MARE ISLAND—Until 11 A. M., Jan. 1 by Bureau Yards and Docks, Navy Dept., Washington, D. C., for 250,000 barrel fuel oil tanks, 3 motor-driven centrifugal oil pumps; one motor-driven centrifugal pump for fresh water; one motor-driven foam chemical agitating pump, etc., delivery of same at Navy Yard, Mare Island, Cal.

CAL., SAN FRANCISCO—Until 3 P. M., Jan. 9th, by Board Public Works, City Engineer, 3rd floor City Hall, for furnishing butterfly valves to be used in connection with penstock lines for the Moccasin Creek Power Plant of Hetchy project, cost $40,000.

D. C., WASHINGTON—Until 2 P. M., Jan. 8th, by Department Agriculture, Washington, D. C., Director of Purchases and Sales, for furnishing and delivering prepaid at Bound Brook, N. J., 50 tons of powdered arsenate of lead.

MINN., ST. PAUL—Until 2 P. M., Jan. 2nd, by H. W. Austin, City Purchasing Agent, for gate valves, structural steel, miscellaneous steel and iron pipe for water department; G. M. Shepard, City Engineer.

MINN., ST. PAUL—Until 2 P. M., Jan. 2nd, by H. W. Austin, Purchasing Agent, City Hall, for furnishing approximately 20,000 lb. liquid chlorine in 100 or 150 lb. suitable cylindrical containers required by Bureau of Water during 1924.

MINN., ST. PAUL—Until 2 P. M., Jan. 2nd, by H. W. Austin, City Hall, for furnishing gate valves for Water Department.

MINN., ST. PAUL—Until 2 P. M., Jan. 2nd, by H. W. Austin, Purchasing Agent, City Hall, for furnishing 34 porcelain enameled iron bubble fountains required for school department.

MINN., ST. PAUL—Until 2 P. M., Jan. 2nd, by Purchasing Agent H. W. Austin, City Hall, for furnishing and delivering material for Water Department, approximately 35,579 lb. structural steel and 4,023 lb. miscellaneous iron and steel.

MINN., WINONA—Until 8 P. M., Dec. 31st, by City, at office of City Recorder, for furnishing and delivering F. O. B. cars on either C. & N. W. or C., M. & St. P. Ry. tracks at Front and High Forest Sts., approximately 9,126 lb. special iron castings and 18 and 12 in. class "A" water pipe in 12 ft. lengths, as follows, 18 pieces with 2 flanges, 1 piece with bell and flange, 16 pieces with bell and spigot; total estimate cost, 3,345.74.

NEB., FREMONT—Until 2 P. M., Jan. 2nd, by Board Public Works, J. Rex Henry, Acting Chairman, for 8 8 in. wells with brass strainers, 20 in. and 8 in. C. I. bell and spigot suction pipe and C. I. fittings; 2 centrifugal pumps with motor and air chambers; estimated cost $13,900.

NEBR., FREMONT—Until 2 P. M., Jan. 2nd, by J. Rex Henry, Arcting Chairman, Board Public Works, for 8 8 in. wells with brass strainers, all 20 in. and 8 in. c i bell and spigot suction pipe, 2 centrifugal pumps; estimated cost $13,900.

N. Y., NEW YORK, MANHATTAN—Until 11 A. M., Jan. 2nd, by Commissioner Water Supply, Gas and Electricity, Room 2351 Municipal Bldg., for constructing chlorinating plant at Kilday Brook near the village of Katonah, Westchester County, N. Y.

N. Y., NEW YORK—MANHATTAN—Until 11 A. M., Jan. 2nd, by Commissioner Water Supply, Gas and Electricity, Room 2351 Municipal Bldg., Manhattan, for furnishing, delivering, and laying water mains and appurtenances in Hawtree Creek, Hasbrouck, and several other streets.

N. C., ASHEBORO—Until 2 P. M., Jan. 10th, by Town Council of Asheboro, Jas. N. [illegible]ley, Clerk, for water works improvements and sanitary sewer extensions, 500,000 gallon filter, 250,000 gal. concrete reservoir, etc.

PA., ERIE—Until Jan. 23rd, by Geo. C. Gensheimer, Secretary, Commissioner Water Works, for erection of a 20,000,000 gal. triple transmission fly wheel and condensing pumping engine; J. N. Chester, Union Bank Bldg., Pittsburgh, Pa.

Sewerage - Sanitation

IND., INDIANAPOLIS—Until 2 P. M. Jan. 2nd by Board Public Works, for Local Sewer Improvement, Resolution No. 11424 on Hiawatha St. from Michigan to Walnut St.

IND., TELL CITY—Until 7:30 P. M., Jan. 15th, by Common Council of Tell City, for construction of a concrete and vitrified sewer in Fulton St., with branches in Ninth, Eleventh and Ruben St.

MINN., ST. PAUL—Until 2 P. M., Jan. 2nd, by H. W. Austin, City Hall, Purchasing Agent, for sewer on Park Ave. from Wabasha to Como Ave.; (2) on Viola St. from Park Ave. to Capitol Blvd.; (3) lateral sewer on Como Ave. from sewer on Park Ave. to East line of Park Ave.

MINN., ST. PAUL—Until 2 P. M., Jan. 2nd, by H. W. Austin, Purchasing Agent, for construction of sewer on West Seventh St. from Parmer to Albion Ave.

MINN., ST. PAUL—Until 2 P. M., Jan. 2nd, by H. W. Austin, Purchasing Agent, City Hall, for construction of Sewer on Lawton St. from north side of Pleasant Ave. to Harrison Ave.; (2) Sewer on Davern Ave. from Mississippi River to West 7th St.

MINN., ST. PAUL—Until 2 P. M., Jan. 2nd, by H. W. Austin, Purchasing Agent, City Hall, for a sewer on Southerly side of Pleasant Ave. from Lisbon St. to point 15 ft. west of East Line of Lot 71 in subdivision of Leech's outlots.

MINN., ST. PAUL—Until 2 P. M., Jan. 2nd, by H. W. Austin, City Purchasing Agent, for sewer extending on several streets.

MO., VERSAILLES—Bids will be taken about Jan. 1st, for lateral sewers; E. T. Archer & Co., 609 New England Bldg., Kansas City, Construction Engineers.

NEB., FAIRBURY—Until 8 P. M Jan. 2nd, by City, H. W. Fotts, Clerk, for storm sewers in paving districts 2 and 6, estimated cost, $7,511.45.

NEBR., FAIRBURY—Until Jan. 2, 1924, by City of Fairbury, N. M. Collier, City Engineer, for approximately 12 to 24 in. storm sewer, 2,500 ft. length.

PA., PITTSBURGH—Until 8 P. M., Jan. 7th, by Chas. A. Woelfel, President Board of Commissioners, for construction of a 15 in. terra cotta sewer on Borough St. and through existing sewer on Spring Garden Ave.; F. G. Ross, Engineer, 309 Fourth Ave., Pittsburgh.

TENN., McKENZIE—Until 2 P. M., Jan. 3rd, by H. C. Bryant, City Clerk, for complete sewer system for city, 45,700 lin. ft. vitreous pipe, sewers 8 to 15 in.; 135 manholes; 2 reinforced concrete settling tanks; 12 flush tanks.

WIS., SUPERIOR—Until 1:30 P. M., Dec. 31st, by Board Public Works, City Hall, for constructing sewer in Hudson Ave. between East Second and East Third Sts.

WIS., SUPERIOR—Until 1:30 P. M., Dec. 31st, by Board of Public Works, City Hall, for constructing sewer in alley between 22nd St. and Faxon St.

WIS., SUPERIOR—Until 1:30 P. M., Dec. 31st, by Board of Public Works, City Hall, Superior, for the construction of a sewer in alley between West 8th and West 9th Sts.

Buildings

CAL., LOS ANGELES—Until 11, Dec. 31st, by Board of Supervisors, Los Angeles, for furnishing all labor and material for construction work of extension to laundry including new concrete oil tank at County Farm.

CAL., LOS ANGELES—Until 9 A. M., Jan. 2nd, by Board Education, Room 729 Security Bldg., for furnishing labor and material, for erection of gymnasium buildings on San Fernando and San Pedro High School building sites.

CAL., LOS ANGELES—Until 11 A. M., Jan. 7th, by Board Supervisors, County of Los Angeles, L. E. Lampton, Clerk, for furnishing labor and material necessary to complete plumbing, heating and service piping for extension of Laundry Bldg. at County Farm.

CAL., LOS ANGELES—Until 11 A. M., Jan. 7th, by Board Supervisors, County, for furnishing labor and material, for remodeling Superintendent's cottage, including fitting up office in crematory at Los Angeles County Cemetery, 3301 E. First St., Los Angeles.

CAL., SACRAMENTO—Until 2 P. M., Jan. 7th, by California Highway Commissioners, 515 Forum Bldg., for construction of portion of State Highway (1.9 miles length paved with portland cement concrete), also 13 miles part graded and part paved with cement.

D. C., WASHINGTON—Until Jan. 9th, by Bureau of Yards and Docks, Navy Dept., Washington, for addition to barracks at naval radio compass station, Cape Hatteras, N. C.

D. C., WASHINGTON—Until Jan. 9th, by Bureau Yards and Docks, Navy Dept., Wash., for remodeling quarters and for new boat house at naval radio compass station.

D. C., WASHINGTON—Until Jan. 9th, by Navy Department, for underpinning 38 concrete pile footings

of Navy Department Bldg., 18th and B Sts., N. W., Washington.

D. C., WASHINGTON—Until 3 P. M., Jan. 2d, by Jas. A. Wetmore, Acting Supervising Architect, for construction and mechanical equipment of post office building at Liberty, Mo.

ILL., CHICAGO—Until 1 P. M., Jan. 7th, by H. A. Zender, Superintendent Public Service, Room 519 County Bldg., City, for concrete fence for new Juvenile Home building.

ILL., URBANA—Until 2 P. M., Feb. 4th, by Jas. M. White, Supervising Architect, 256 Administration Bldg., Urbana, for general work on four buildings to be erected for University of Illinois.

IND., INDIANAPOLIS—Until 11 A. M., Jan. 3rd, by Board of Agriculture, H. M. Moberly, President, at Statehouse, for erection, construction and completion of a cattle pavilion, including plumbing, sewering, etc.; J. Edw. Kopf & Wooling, Indiana Pythian Bldg., Indianapolis, Engineers.

IA., KEOSAUQUA—Until 1 P. M., Jan. 10th, by Van Buren County, C. E. Armstrong, County Auditor, for Federal Aid Project 165, Sec. G., grading and draining 1.242 miles in Keosauqua; 30,340 cu. yd. earth excavation, 244 ft. 12 in. tile drain, 6 tile intakes, 30 lin. ft. 24 in. culvert pipe, 12,200 sta. yd. overhaul.

KAN., BELLE PLAINE—Until 7:30 P. M., Jan. 9th, by Board of Education, for Belle Plaine School.

KANS., BELLE PLAINE—Until 7:30 P. M., Jan. 9th, by School Board, for erection of school building. Lorentz Schmidt & Co., Architects, Wichita, Kans.

KAN., MANHATTAN—Until 7:30 P. M., Jan. 3rd, by Board Education at Manhattan, for erection of grade school building; Thos. W. Williamson & Co., Topeka, Architects.

KY., DAYTON—Until 12 Noon, Dec. 28th, by Trustees of Speers Memorial Hospital, Dayton, for erection of a Nurses' Home; C. C. & E. A. Weber, Architects, Ingalls Bldg., Cincinnati.

KY., LOUISVILLE—Until Dec. 28th, by U. S. Engineer, Custom House, Louisville, for 20 squares asphaltum roofing felt, 30 pounds roofing nails, 300 squares elastic cement, roofing, accessories.

MO., PARKVILLE—Until 2 P. M., Jan. 4th, by Board of Trustees, Park College, for furnishing all materials and labor to complete science building. J. H. Felt & Co., Architects, Kansas City, Mo.

NEV., CARSON CITY—Until 1:30 P. M., Jan. 2nd, by Geo. W. Borden, State Highway Engineer, Carson City, Nev., for grading, construction of culverts and placing selected material surface in Lander Co. Until 2:30 P. M., Jan. 2nd, for grading, construction of culverts and placing gravel surface in Clark County, between Mormon Mesa and the Nevada-Arizona State line.

N. J., BORDENTOWN—Until 3 P. M., Jan. 3rd, by Guilbert & Betelle, Architects, State House, Trenton, for furnishing labor and materials to construct dormitory building at Manual Training and Industrial School for Colored Youth, Bordentown.

N. J., NEWARK—Until 8:05 P. M., Jan. 9th, by Board Education of Newark, R. D. Argue, Secretary, for construction and completion of Maple Ave. School.

N. J., TRENTON—Until 3 P. M., Jan. 3rd, by Architects, State House, Trenton, for building dormitory at Manual Training and Industrial School for Colored Youth, Bordentown.

N. Y., BUFFALO—Until 10 A. M., Dec. 28th, by Board Education, Room 1400 Telephone Bldg., New York, for repairing roof and ventilators at School No. 57, New Building, 231 Sears St.

N. Y., BUFFALO—Until 11 A. M., Jan. 3rd, by Department Public Works, Room 5 Municipal Bldg., for paving Highgate Ave., 28 ft. wide and Freeman St., 26 ft. wide, also paving on Copsewood Ave., Rhode Island and Ashland Ave.

N. Y., LONG ISLAND CITY—Until 11 A. M., Dec. 28th, by President Borough of Queens, 4th floor Queens Subway Bldg., 68 Hunterspoint Ave., L. I., for construction of a bulkhead at end of 3rd St. on Westerly side of Dutch Kills Creek.

N. Y., NEW YORK—Until 12 Noon, Jan. 8th, by Wm. H. Gompert, Architect, Board Education, S. E. corner Flatbush Ave., Extension and Concord St., for general construction of new public school, 80 on the northeast corner or East Mosholu Parkway.

N. Y., NEW YORK—Until 12 Noon, Jan. 8th, by Wm. H. Gompert, Architect, Board of Education, S. E. corner Flatbush Ave. and Concord St., Brooklyn, for general construction of new public school 109, on southerly side of 92nd Ave.

N. Y., NEW YORK, MANHATTAN—Until 10:30 A. M., Jan. 2nd, by Commissioner, Purchase of City of New York, Room 526 Municipal Bldg., for furnishing and delivering ball bears, drive and skid chains to Fire Department and department of Street Cleaning.

N. Y., NEW YORK, MANHATTAN—Until 12 Noon, Jan. 3rd, by Wm. H. Gompert, Architect, Board of Education, southeast corner Flatbush Ave. and Concord, for general construction of an addition t public school 16 (and work in connection therewith on the easterly side of Daniel Low Terrace, through to Monroe Ave., 175 ft. north of Corson St., Borough of Richmond.

N. Y., NEW YORK, MANHATTAN—Until 10:3 A. M., Dec. 29th, by Department Public Welfare, 10th floor, Municipal Bldg., for furnishing all labor and materials required for installing new floor tiling o first floor Greenpoint Hospital.

N. Y., NEW YORK, MANHATTAN—Until 12 Dec. 28th, by Commissioner Docks, office Pier "A," foot Battery Pl., North River, for removing presen roofings, cutters leaders, and lead tubes on Pier 12 East River, foot Wall St., and for replacing wit new roofings, gutters, leaders and leader tubes.

N. C., RALEIGH—Until 12 Noon, Jan. 7, by John C. Lockhard, Secretary, Wake County Board of Education, Court House, for construction of addition t Wendell High School.

O., COLUMBUS—Until 12 Noon, Jan. 12th, by Board of Trustees of Ohio State University, office o Secretary of Board, Carl E. Steeb, for furnishing material and labor for construction of Greenhouse on the campus.

O., SPRINGFIELD—Until Jan. 8th, by Independent Order of Odd Fellows, Chas. Baynton, Chairman 3818 Spokane Ave., Cleveland, for new Odd Fellows Home, $100,000, 2 story and basement; also building Home (children's addition), to cost approximately 90,000, brick and stone trim; Hall & Lethley, 211 N Limestone St., Springfield, O., Architects.

O., WILLOUGHBY—Until Jan. 11th, by Board o Education, for school building at Center and River Sts.; Franz Warner, Architect, Hippodrome Annex.

O., ZANESVILLE—Until 12, Dec. 31st, by C. J. Weaver, Clerk Board Education of Zanesville City School District, for furnishing material and performing necessary labor and alterations and additions to a high school building on corner North and 6th Sts.

S. C., PARRIS ISLAND—Until Dec. 29th, by Quartermasters' Department, Marine Barracks, Parris Island, for furnishing 350 barrels portland cement.

S. C., WALTERBORO—Until 12, Jan. 3rd, by School Commissioners of School District, for high school building; Jas. B. Urquhart, Architect, No. 607 Palmetto Bank Bldg., Columbia, S. C.

TEX., BRADY—Until 10 A. M., Jan. 15th, by Evans J. Adkins, County Judge, for improvement of certain highways in McCulloch County, clearing and grubbing, excavation; E. A. Burrow, County Engineer, Brady, Tex.

TEX., DEL RIO—Until Jan. 9th, by Val Verde County, for grading constructing concrete drainage structures and gravel 12.74 miles road, 15 miles north of Del Rio; 88,851 lb. reinforced steel; approximate cost $80,000; G. M. Jowers, County Engineer.

TEX., DENTON—Until Jan. 11th, by Denton County, H. T. Brewster, County Engineer, for 5.59 miles gravel road on State Highway No. 39, from Little Elm to Collin County line.

TEX., FRANKLIN—Until Jan. 11th, by Robertson County, for 9.74 miles gravel road on State Highway No. 43-A, Federal Aid Project No. 400, Section A; L. A. Peterman, Engineer.

VA., QUANTICO—Until Dec. 28th, by Quartermasters' Department, Marine Barracks, for 400 lb. liquid chloride.

WASH., SEATTLE—Until 11 A. M., Jan. 3rd, by Seattle School District No. 1, Reuben W. Jones, Secretary, for general work, heating and ventilating, plumbing and electrical work, for addition to John Muir School.

WIS., MILWAUKEE—Until 2 P. M., Dec. 28th, by County Clerk, Wm. J. Cary, for furnishing material and doing work required in remodeling office of civil service commission, located in court house annex, corner Jefferson and Oneida Sts.

CAN., TORONTO—Until 12 Noon, Jan. 4th, by H. H. Couzens, General Manager, Toronto Transportation Commission, 35 Yonge St., for the construction of a brick maintenance shop at Hillcrest Yard, Bathurst St. and Davenport Road, Toronto.

Miscellaneous

MICH., DETROIT—Until 11 A. M., Jan. 2nd, by Department Purchases and Supplies, 7th floor Marquette Bldg., Detroit, for furnishing Department Street Railways with one power squaring shear.

MICH., DETROIT—Until 10:30 A. M., Jan. 7, by Dept. of Purchases and Supplies, 7th floor, Marquette Bldg., for:

1,000 tons rails.
250 pair compromise joint plates.
750 pair joint plates.

MINN., MINNEAPOLIS—Until 3 P. M., Dec. 28th, by City Purchasing Agent F. S. Gram, 223 City Hall, for furnishing the city with one ton truck and one 2-ton truck.

MINN., ST. PAUL—Until 2 P. M., Jan. 2nd, by H. W. Austin, City Hall, for furnishing globes and glass canopies required for Bureau of Lighting.

MO., CAMERON—Until 10 A. M., Dec. 29th, by City of Cameron, for furnishing and installing Oil Engines and other equipment in New City Light & Power Plant.

N. Y., ALBANY—Until 12 Noon, Jan. 17th, by Royal K. Fuller, Commissioner, Canals and Waterways, for completing excavation of the canal channel in Genesee River at Rochester and placing rock spoil protection along river banks.

N. Y., NEW YORK CITY—Until 12 Noon, Jan. 14th, by U. S. Engineer's Office, Room 710 Army Bldg., 39 Whitehall St., New York City, for dredging in harbor at Flushing Bay, N. Y.

N. Y., NEW YORK, MANHATTAN—Until 11 A. M., Dec. 31st, by Department Water Supply, Gas and Electricity, Room 2351, Municipal Bldg., Manhattan, for furnishing and maintaining and laying electric lighting units for Lighting Public Streets.

N. Y., NEW YORK, MANHATTAN—Until 10:30 A. M., Dec. 28th, by Commissioner Purchase of City, N. Y., Room 526 Municipal Bldg., for furnishing and delivering compressor motor, cleaners and hose to Fire Department.

N. Y., NEW YORK, MANHATTAN—Until 12, Dec. 28th, by J. H. Delaney, Commissioner Docks, office Pier "A," foot Battery Pl., North River, Manhattan, for dredging slip, west side, Pier 4, East River, Borough Manhattan.

N. Y., SONYEA—Until 2 P. M., Jan. 8th, by Percy L. Lang, President Board of Managers, Craig Colony, for construction of fire escape.

N. Y., NEW YORK, MANHATTAN—Until 11 A. M., Dec. 29th, by Commissioners Docks, office Pier "A," foot Battery Pl., North River, for dredging at Bay Ridge Ave. in Borough Brooklyn; (2) dredging at 52nd St. Pier.

O., CINCINNATI—Until 11 A. M., Jan. 19th, by U. S. Engineers office, for furnishing, delivering and erecting gates for Lock No. 34, Ohio River. (Adv. in this issue.)

PA., PHILADELPHIA—Until 12 Noon, Jan. 9, by War Dept., U. S. Engineer Office, Room 1307, Schaff Bldg., 1505 Race St., for construction and delivering one wooden scow.

PA., STEELTON—Until Dec. 28th, by Borough of Steelton, Secretary, 214 Walnut St., Steelton for a one-ton truck for the highway department.

S. C., PARRIS ISLAND—Until Dec. 28th, by Quartermaster's Depatrement, Marine Barracks, for furnishing 203 boiler tubes.

VA., WEST POINT—Until 12 Noon, Jan. 9th, by School Board of Town of West Point, for construction and steam heating proposals for the erection of high school building in Town of West Point.

CAN., ONTARIO—PEMBROKE—Until 12, Jan. 9th, by Department Public Works, L. H. Colman, secretary, for the reconstruction of public wharf and dredging a basin and boat channel at Pembroke.

CAN, OTTAWA—Until Jan. 15th, by J. W. Pugsley, Secretary Department Railways and Canals, for construction of Section 8, Welland Ship Canal.

To Our Readers

Business and professional papers have developed in America more rapidly than in any other nation. Few readers know the underlying cause of this development. It is the relatively large volume of advertising carried by these periodicals. If publishers had to depend solely upon income from subscriptions, they could not afford to publish either the quality or the quantity of articles and news now provided.

It is well to remind readers from time to time that advertising is a great educational force that acts not only directly through the advertising pages but indirectly through the "reading pages" of periodicals. Although the "reading pages" of a high class periodical are edited in the interest of the readers, still it should be remembered that the number of those pages would be fewer and their contents lower in quality were it not for the economy resulting from the combination of advertisements and articles in one publication.

Hence if a reader wishes to see a magazine thrive and improve, he will do well to act upon the request to mention the magazine when writing for catalogs or prices. Records of such "mentions" are kept by most advertisers, and the quantity of advertising secured by a magazine is largely determined by the number of inquiries traceable to it.

In a sense, then, the readers thus vote in favor of the prosperity of the magazine that they "mention" oftenest.

We thank our readers for their courtesy in mentioning Engineering and Contracting so frequently, and ask them to follow the request printed at the bottom of each advertising page.

"Tell Them You Saw Their Ad. Here"

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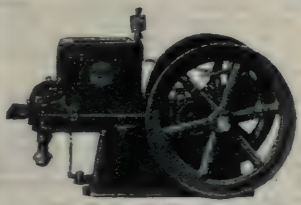

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The experience of use has proven them—That's why they are so universally used on bull wheel derricks.

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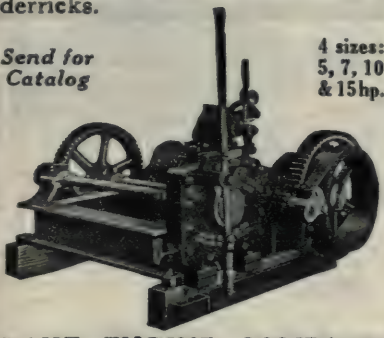

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LEGAL NOTICE

FILTER PLANT ADDITION

Erie, Pa., Nov. 22, 1923.

Sealed proposals for the construction of an 8 million gallon addition to the filters, together with all appurtenances will be received by the Commissioners of Water Works in the City of Erie, Pa., at the Water Works Office, in said City until twelve o'clock noon, eastern standard time, Thursday, January 3, 1924, and will then be opened and read publicly.

All bids shall be made upon the official Proposal Blanks attached to the Instructions to Bidders, Specifications, Form of Contract and Bond, which may be seen at the office of the Water Commissioners in the City of Erie, or may be had by bone fide bidders upon application to the J. N. Chester Engineers, Union Bank Building, Pittsburgh, Pa., on deposit of a certified check for Ten Dollars ($10.00), which will entitle the bidder to one set of plans and specifications covering the item on which he intends to bid. Proper receipt for each such deposit will be given and the money will be refunded providing plans and specifications are returned in good condition within ten (10) days after the reception of bids.

Each proposal shall be accompanied by a certified check made payable to the order of the Commissioners of Water Works in the City of Erie, for two per cent (2%) of the total amount of the bid. This check is to be conditioned that if bid is accepted a contract will be entered into and the performance of the same secured within ten days after notification of acceptance of the bid. In case the bid is rejected or contract entered into, the check will be returned. Successful bidder will be required to furnish a corporate surety bond in an acceptable surety company in the full amount of the contract.

A bid bond on a surety company acceptable to the City in the amount of two per cent (2%) of the total amount of the bid will be acceptable in lieu of certified check.

The right is reserved to reject any or all bids.

COMMISSIONERS OF WATER WORKS
IN THE CITY OF ERIE, PA.
By George C. Gensheimer, Sec'y.

THE J. N. CHESTER ENGINEERS,
Union Bank Building,
Pittsburgh, Pa.

U. S. ENGINEER OFFICE, CINCINNATI, Ohio. Seal proposals for furnishing, delivering and erecting gates for Lock No. 34, Ohio River, will be received here until 11 A. M., January 19, 1924, and then opened. Information on application.

U. S. ENGINEER OFFICE, P. O. Box 72, Louisville, Ky. Sealed proposals will be received here until 2 p. m., central time, December 29, 1923, and then opened, for furnishing and delivering Metal Work for Dams Nos. 44 and 45, Ohio River. Further information on application.

U. S. ENGINEER OFFICE, P. O. Box 72, Louisville, Ky.—Sealed proposals will be received here until 2 p. m., central time, Jan. 3, 1924, and then opened, for furnishing, delivering and erecting gates for Lock No. 45, Ohio River. Further information on application.

U. S. ENGINEER'S OFFICE, MILWAUkee, Wis. Sealed proposals will be received here until 3 p. m., Jan. 16, 1924, and then opened, for constructing steel dump scows and barge. Further information on application.

U. S. ENGINEER'S OFFICE, 250 OLD Land Office Building, Washington, D. C. Sealed proposals will be received here until 12 M., January 15, 1924, and then opened, for the construction of the Filtration Plant and Pumping Station substructures for the District of Columbia water supply project. Further information on application.

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STEAM SHOVELS
The KEYSTONE traction steam shovel is usable with three different interchangeable scoops—*Skimmer, Ditcher and Clam Shell*—for Road Grading, Trenching, Back-Filling, Cellar Digging, Pit Mining, Loading, Unloading and Handling Materials.

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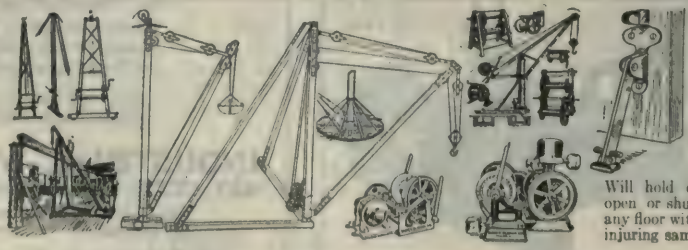

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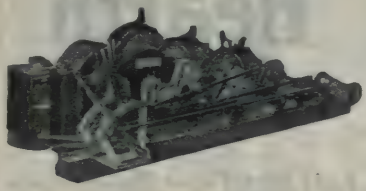

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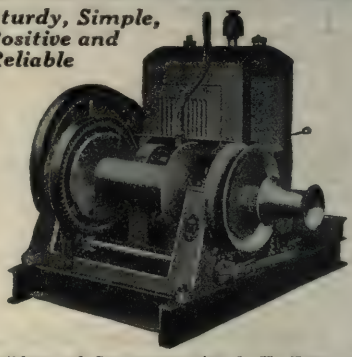

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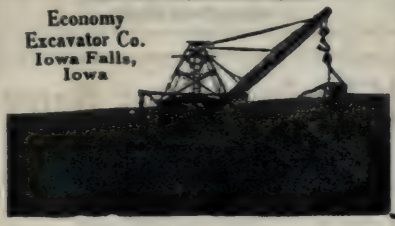

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